INSTRUMENTS AND AUTOMATION

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The Model 62 RT4F Resistance Thermometer is a sturdy, easy to read instrument with a six inch hand drawn scale. It is suitable for use in moving vehicles, is excellent for flight testing or for permanent panel installations. Operated by an ordinary dry cell and calibrated to standard "AN" bulb curves, this instrument is ideal for use with any of the resistance bulbs illustrated below. Other ranges available in °C or °F.

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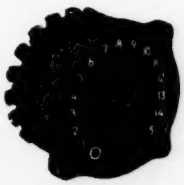
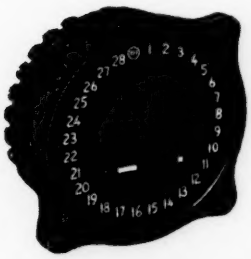


3" SIZE TO 20 POINTS

THREADED "AN" TYPE

THREADED "AN" TYPE



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Built-in Positioner
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Totally enclosed Operator
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INSTRUMENTS AND AUTOMATION

AUTOMATION: The use of devices—mechanical, pneumatic, hydraulic, electrical and electronic—for making automatic decisions and efforts.—MHA

SEPTEMBER 1958

NO. 9 VOLUME 31

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EDITORIAL

Canadian Industry—its likes, needs and attitudes, 1515

INDEPENDENT survey results concerning market for industrial measuring and recording apparatus

FEATURE ARTICLES

Response of Combination Valve Actuators, 1518

NEEDED: a standard method of expressing dynamic response of valve actuators under a standard set of load conditions

Wanted: Inventions, 1524

PARTIAL list of areas in which government is actively seeking new ways of doing things

Derivative Via Integration, 1525

MAX FOGIEL—method for obtaining derivative of a quantity represented by a voltage, without high-frequency noise arising

Wheel And Belt Digital Readouts, 1526

DESCRIPTIONS of available mechanical counters illustrate state of the art

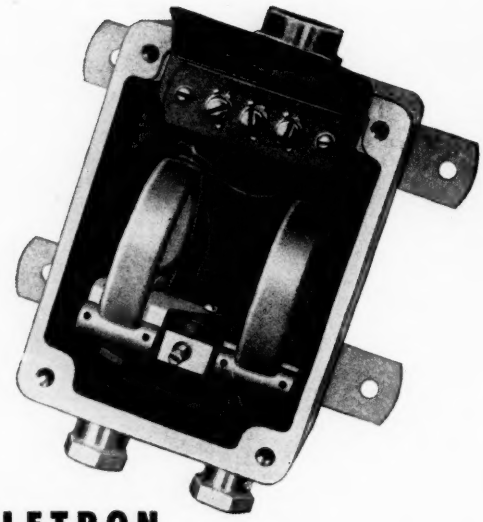
Electronic Circuitry, 1529

C. F. KEZER and M. H. ARONSON—two more basic circuits

Sizing of Conventional Relief and Safety Valves, 1531

L. P. STILLMAN—methods of sizing and selecting are basically the same, but vary some depending on application and governing code

Continued on page 1454



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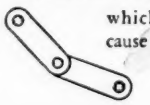

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For more information circle **5** on inquiry card.

INSTRUMENTS and AUTOMATION

VOL. 31, NO. 9 • SEPTEMBER, 1958

Continued from page 1453

The Journal of THE SOUTHERN CALIFORNIA METER ASSOCIATION

Computation of Orifice-Meter Gas Coefficients, 1537

W. J. KENNEDY—standard procedure for coefficient calculation by using these computation factors in a standard sequence

THE SIMULATION COUNCIL NEWSLETTER

Combined Analog-Digital Simulation, 1543
Submarine Simulation, 1544
System Optimizing, 1546

OTHER REGULAR FEATURES

Letters to the Editor	1456	Panhandle Pete	1509
Trends	1465	New Instruments	1550
News	1468	New Plants and Mergers	1578
Stock Report	1474	People in the News	1580
Briefs	1480	New Literature	1582
Biographies	1489	Advertisers' Index	1596
Events	1497		

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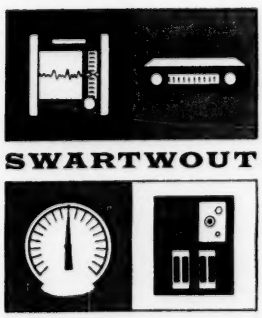

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S.A. 1660

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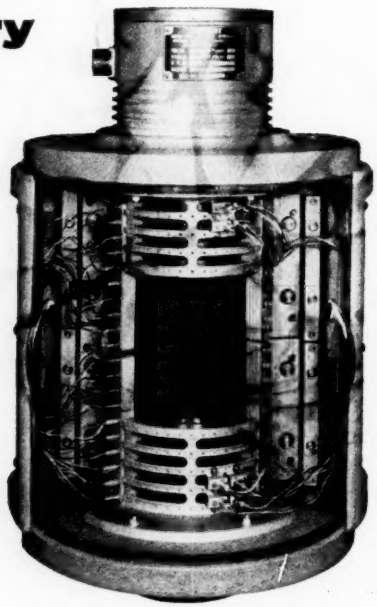

with a standard multiple purpose off-the-shelf drum

The 512-A Bryant general purpose magnetic storage drum meets the exacting requirements of a production component, yet has the versatility necessary for laboratory work. This standard 5" dia. x 12" long drum is stocked for immediate shipment, complete with standard components such as general storage brackets, recirculating register brackets and magnetic read/record heads. Its low price reflects the benefits of Bryant's 25 years' experience in the efficient design and production of high speed precision spindles.

Features:

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BRYANT CHUCKING GRINDER CO.

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to the editor

Editor, I&A:

Subject: Request for Fluid Flow Measurement Problems.

The Southern California Meter Association has recently extended its scope to include the missile and aircraft industries in addition to the process, natural gas and petroleum industries. As a result we are now surveying the missile and aircraft industries through the Aircraft Industries Association to learn their fluid flow measurement capabilities and problems so that we can adequately serve these industries.

To do this we need the specific details of these flow measurement problems from the SCMA members in or related to the missile and aircraft industries. Once we know these problems, we will tackle the problems bothering the majority first and then methodically wade through the others to some eventual satisfactory conclusions. Please state the problems you would like to see worked on by letter or by phone call to the writer. The phone number is NAtional 9-5111, Extension 4153.

Lowell A. Holcomb
Chairman
SCMA Instrumentation Committee
Convair
Pomona, Calif.

Editor, I&A:

Referring to the article "Evaluation Factors for Recorders" in the May 1958 issue, the values you quoted for the Acton recorder do not check in the equation $T=RM/S_{max}$. For example, $R_1 = 100{,}100$ widths/second (from Fig. 1 at 1 cps).

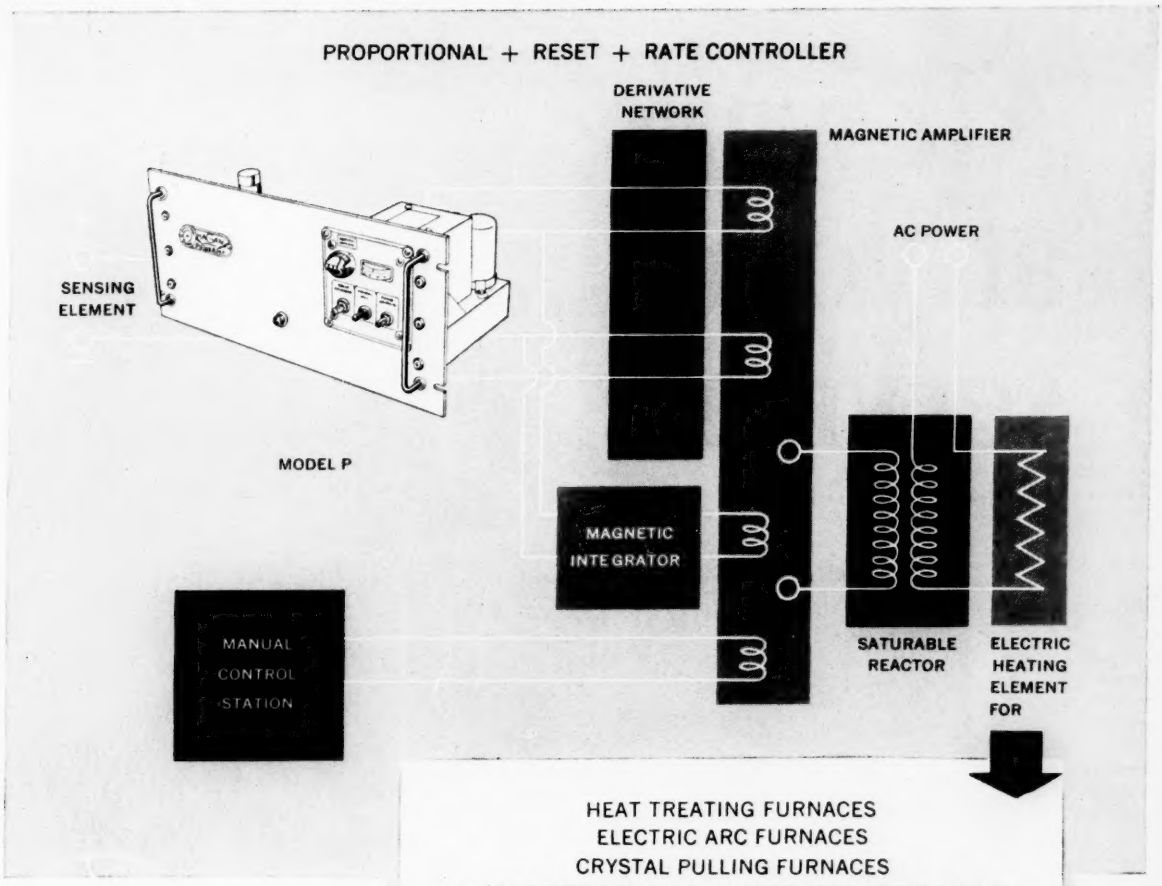
$$W = S_{max}/R_1$$
$$= \frac{0.525 \text{ cps}}{100{,}100 \text{ wps}}$$
$$= 5.1 \times 10^{-6} \text{ ft}$$
$$= 6.2 \times 10^{-5} \text{ inch},$$

indicating a narrow trace of only 0.000062 inch. Since this would be invisible, there must be another mistake, in either S_{max} or R.

A. G. Fonda
Cornell Aeronautical Lab., Inc.
Buffalo 21, New York

The units used in the article under discussion were not clearly explained.

Referring to Fig. 1 in the article it is seen that the resolving power of recorder 1 is 1,050 at 100 cps. This figure (not the R at 1 cps) was used



HAGAN POWRAMP

All Electronic TEMPERATURE CONTROLLER

all electronic—set point resolution—0.1% of range—handles up to 330 kva

Small in size and economical in cost, the Hagan PowrAmp Temperature Controller is a precision control system for all types of electric heating applications. Using the PowrAmp Model "P" for initial amplification of the sensing element signal and magnetic amplifiers for summing and integration, this Hagan controller virtually eliminates the need for periodic maintenance.

Proportional band, reset and rate action are all available to fit process requirements. The Hagan Temperature Controller has a precision digital set point, and provides stepless fractional degree regulation, even at high temperature levels.

The Hagan controller is particularly valuable in precise temperature applications where either the heater or the product temperature can change rapidly. The Controller is part of the Hagan PowrAmp line which includes transducers for most key variables, electronic control computers and high power electro-hydraulic servo valves. Write for Bulletin MSP-133, which describes the full PowrAmp line.

For additional information on the Hagan Temperature Controller, write for Specifications Sheet GE 60001.

HAGAN CHEMICALS & CONTROLS, INC.
HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
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Honeywell

First in Control

LETTERS—CONTINUED

to obtain the recording time factor T of 10,830. However, this means that in any comparison with other recorder, its resolving power (R) at 100 cps must be used. Using a normalized R would have obviated this.

Also, in order to compare the cost factors with other recorders, M (length of recording medium) must be in feet; S_{max} (max speed) must be in inches per second; and price P must be in dollars for the length of medium used. Using these units, the 4.61×10^{-4} figure will result. Comparison with other recorders must be made using these same units.

Editor, I&A:

As you probably know, the I.S.A. is sponsoring an Educator's Workshop in Philadelphia to consider the need for instrumentation technicians and methods of meeting this need. I have been invited to present ideas and suggestions relating to job qualifications and training. It is in connection with this that I would value your opinion.

In an editorial in the November 1957 issue of (a control journal), the editors state that the technician must be "... well-grounded in the fundamental sciences, in mathematics up through calculus, and in the principles of measurement and control."

I would appreciate your opinion on this. Would you expect that a technician would normally be called upon to employ calculus in his normal routine?

I might add that I am a technician, and have been for over twenty years, although my field has been radio, radar, and television, up until two years ago; and I have never been called upon to employ any mathematics above simple algebra.

I would also like to add that I was amazed and pleased to read "Pittsburgh's answer to Sputnik," and I agree with the substance of your editorial.

A. G. Hathaway
United Electronics Laboratories
Louisville, Kentucky

We agree with you that the technician need not "be well grounded through the calculus." He could have an introduction to the calculus and perhaps understand a simple differential equation—but he need not be "well grounded." Such glittering generalities are easy to say—and impossible to attain.

RAMBLINGS ON INSTRUMENTATION

Tom Schwift and His Marvelous Flow Transmitter

One somnolent August morning, as kindly old Dr. Harding was potting some tea roses in his greenhouse, his attention was distracted by a familiar rapping at his door. "Tom Schwift!" he exclaimed. "Come in, lad!" A moment later Tom Schwift (for it was indeed the young inventor) strode through the door.

"Aha, young Tom!" exclaimed the professor. "Tell me what have you been inventing now, for I detect a note of ill-suppressed excitement in your demeanour."

Blue eyes a-twinkle, the young genius nonchalantly vaulted a row of nasturtiums. "Oh, nothing much," he remarked casually. "Come have a look."

"Smaller than a breadbox!" expostulated the professor.

Back at his laboratory, young Tom beckoned casually toward a draped object in the corner. Spine a-tingle with anticipation, the beloved old professor snatched aside the drape. A gasp escaped his beloved old mouth. For, truly, this latest invention appeared a worthy successor to The Electric Bath Mat, The Automatic Gravy Boat and The Mechanical Chicken Plucker which had brought fame to the modest young genius.

Brushing the mist from his wise old eyes, Professor Harding queried, "And, pray tell, what is it, boy?"

Quelling his amusement at his elder's ignorance, (for he was never one to display impatience in the presence of less nimble wits), young Tom launched into an explanation.

"I've dubbed it the Tom Schwift Flow Transmitter, sir," bespoke the lad, modestly lowering his lashes.

"Bless me!" expostulated Dr. Harding. "But——"

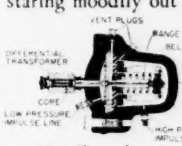
"Notice," Tom went on, "that the entire unit is hardly larger than a steam turbine. Pressure differentials are recorded in this seven-gallon mercury tube, activating a cleverly designed torquing system, which in turn is transmitted to a series of bellows, forcing air into a Navy weather balloon. In early tests, the balloon frequently sailed off with the whole shebang. This difficulty I resolved by bolting the unit to a concrete slab."

Dr. Harding nervously polished his pince-nez. "My boy," he pontificated gently, "the best of us occasionally . . . ahem . . . well, *goof!*"

"You mean . . .?" stammered the lad.

"I fear it is all too true," interjected the older man. "Yes, young Tom, once again Hays has beaten you to the punch! The Hays Model 245 Differential Pressure Transmitter has many points of clear superiority over your crude contraption . . . and, upon my word, over *all* the devices I know about in the flow measurement dodge."

"Smaller, I suppose," brooded Tom, staring moodily out the window.



"The Hays Transmitter is frictionless and liquid-free."

"Smaller than a breadbox," rejoined the other. "Also there are no torque tubes, gears or like that . . . *nothing*, my boy, in the way of mechanical friction. The differential transformer core moves *directly* with the bellows. And the Hays transmitter uses none of that costly mercury, lad. It is liquid-free, the only sensing unit being the single element bellows."

"Jehosophat!" muttered Tom testily.

Warming to his subject, the kindly professor continued: "Another fascinating spec of Hays Fantastic Flow Transmitter, if memory serves, is a guaranteed recorded accuracy of $\pm\frac{1}{4}\%$ of full scale signal above 10% of scale!"

Sensing that his young associate had ceased paying attention, Dr. Harding tiptoed to the door. Closing it gently, he heard the blue-eyed young genius muttering . . . "Wonder if those chaps at Hays have thought of an electric salt shaker!"

(Gentle reader, write for Bulletin 58-1228-107 or "The Hays Boys in the Catskills.")

Phil Sprague Jr. President

THE HAYS CORPORATION • MICHIGAN CITY, 8, INDIANA

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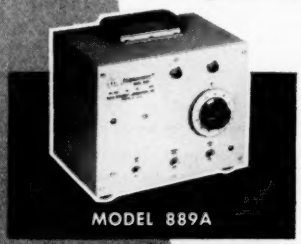
Magnet Calibration

MODEL 1295
DIRECT READING

Gaussmeter

measures magnetic flux density ACCURATELY

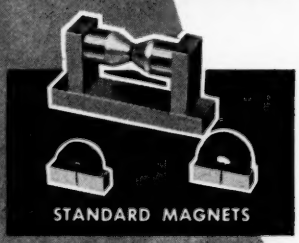
This stable, all transistorized Gaussmeter operates on the Hall effect and provides a conservative accuracy of ±3% over nine full-scale ranges: 0-100, 200, 500, 1 K, 2 K, 5 K, 10 K, 20 K and 20 K + gausses, using a single probe. Two standard Alnico V reference magnets having ¾% accuracy are supplied. Unit is housed in an aluminum case, weighs 12 lbs. and operates from 115-volt, 50-400 cps line. Price $420.



MODEL 889A

Magnetreater®

Model 889A de-magnetizes saturated magnets to any desired level of flux. Provides a precisely controlled method for rapidly treating permanent magnets, including the new core-type instrument mechanisms. Used with Model 206A Booster Unit or Model 107A Magnet Charger. Over-all size is 8" x 10" x 7". Weight 24 lbs. Price $163.



STANDARD MAGNETS

Standard Magnets

Laboratory standard fixed gap reference magnets having flux densities from 100 to as high as 20,000 gausses are now available. These units are fully stabilized magnetically, mechanically and thermally and are used to calibrate fluxmeters and gaussmeters for engineering or production testing. Certification supplied for each magnet.

Performance of all models is rigidly guaranteed. Prices are net f.o.b. Boonton, N.J. and subject to change without notice.

WE CAN HELP YOU

13 years' magnet charging experience is yours for the asking—send for illustrated data sheets.

RFL **Radio Frequency LABORATORIES, INC.**
Boonton, New Jersey, U.S.A.

For more information circle **10** on inquiry card.

Reader Inquiries

How to Stop fhp Motor

Consulting engineer wishes information on method to stop a small synchronous motor of a few watts when a-c voltage from a bridge reaches zero. Motor must stop within one cycle. A-333

Heat-flow Meter

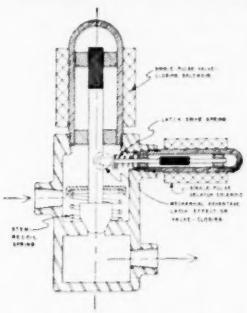
Consulting engineer desires bids on a heat-flow meter to measure heat transfer through large stainless-steel plate, ⅛" thick, which is exposed to radiation on one side and cooled by flowing air on the other. Temperature range to be 1500° F. Meter must be movable to measure BTU/sq ft/hr in area one inch square, making contact on radii varying from 14" to a flat surface. If no such sensing element available, flat shape would be acceptable. A-334

Cartographic Equipment, Seismographs, Magnetometers, Gravimeters

Belgian nuclear development company seeks equipment (to be attached to motor vehicle) which would trace executed runs on road map.—Sources for seismographs, magnetometers, and gravimeters are also sought. A-335

Latching-type Solenoid Valve

Consultant engineer seeks manufacturer of illustrated latching-type solenoid valve and/or other suppliers of similar type. A-336

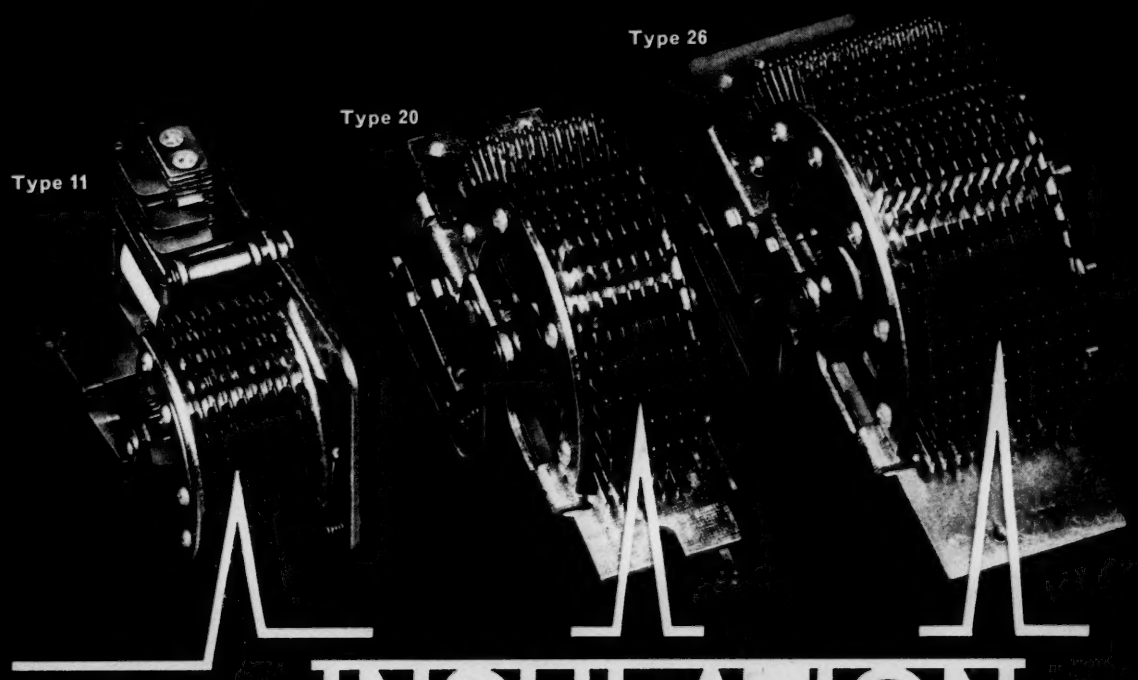


Pyometer and Potentiometer Texts

Sales representative desires texts on millivoltmeter pyrometer controllers and strip chart potentiometers for training program of sales engineers. A-337

Moisture Control in Paper

Belgian paper manufacturer seeks source for moisture controller for paper machine. Moisture content will vary from 3 to 7%. Weight of paper —30 to 150 gr/m². Speed of paper on machine—20 to 120 m/min. A-338



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CLARE RELAYS

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Easy does it

when you postform plastic

with the help of

a Fenwal 541 Temperature Indicating Controller

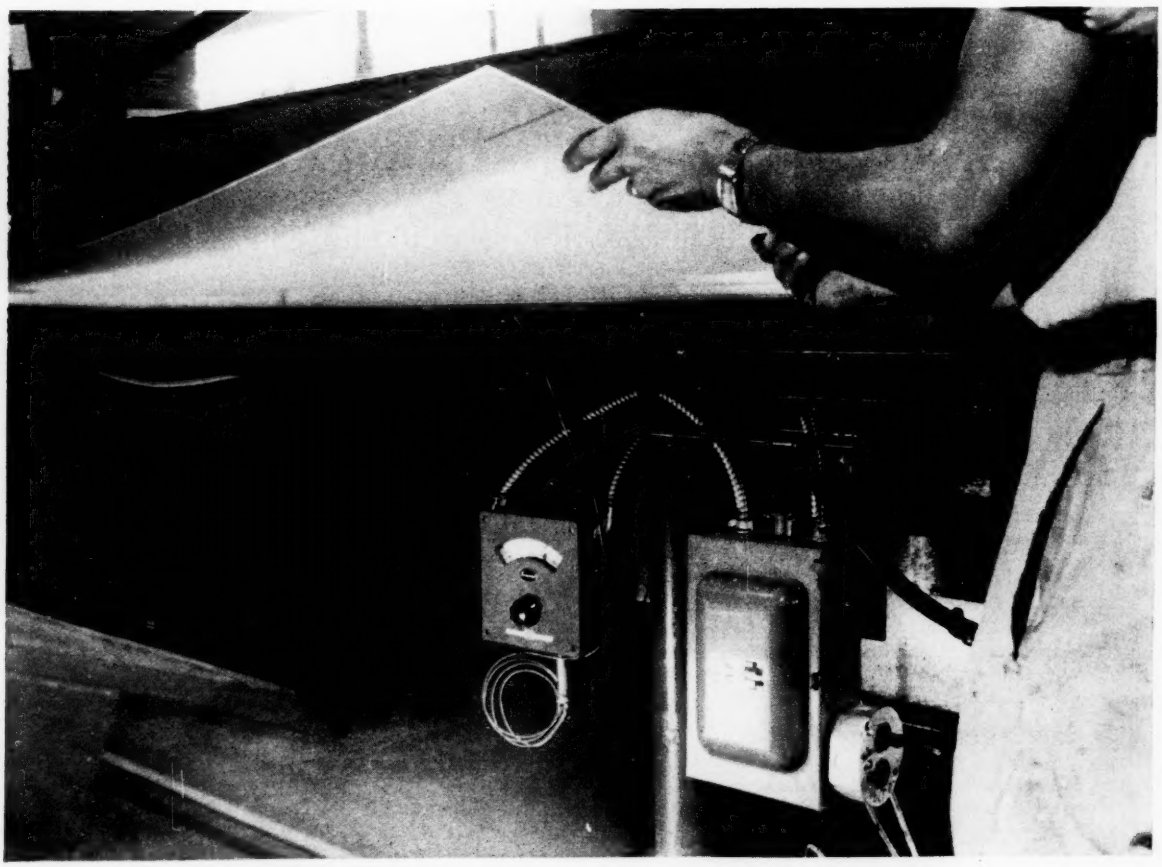
Whether you postform laminated plastic (the machine here is heating a seamless phenolic plastic counter top), or rely on temperature indicating controllers for any of a thousand other reasons, *Fenwal's 541 is the easiest to operate!*

The 541 has a host of long life features — corrosion proof 316 stainless steel, swivel mounted capillaries and bulbs . . . splash and dust proof housing. Self-compensating wear means continued accuracy with minimum maintenance. All components are accessible, easy to adjust. *It's simple and reliable!*

With ranges from −150° to +700°F., the 541 can accurately control one, two, or four circuits. Choose from several bulb and capillary styles, four basic models, variety of housing colors — hundreds of combinations to solve *your* temperature control problem. *It's versatile!*

Find out more about this Fenwal temperature indicating controller that is virtually custom-designed for you. Write to Fenwal Incorporated, 369 Pleasant Street, Ashland, Massachusetts, and ask for a catalog or a sales engineer.

Precise temperature controls on this press make postforming thermoset plastics easy, quick, nearly automatic. This is our single circuit model (there are 575 others) with one SPDT switch and one control pointer. Housings on all Fenwal 541's meet NEMA and JIC specifications.



Fenwal CONTROLS TEMPERATURE . . . PRECISELY

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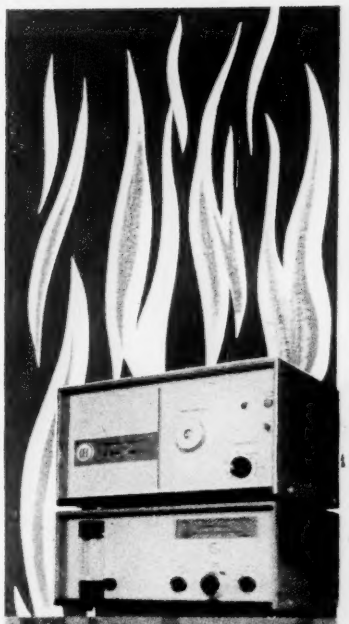
hottest new tool in chromatography

analyzes from hydrogen to waxes



CEC's new 26-014 Analyzer operates at temperatures up to 500°C

CEC's latest advance in chromatography provides another precision instrument for laboratory personnel who are responsible for the measurement of components in complex mixtures. The new 26-014 Analyzer is especially valuable where high-temperature quantitative analyses are required.

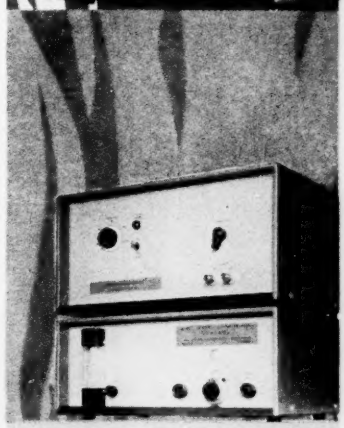
Distinguishing features of the low-cost 26-014 are: adjustable temperature range from 50°C to 500°C, simple hypodermic injection, and filament-type detector providing high sensitivity at high temperatures.

FOR ECONOMY AND VERSATILITY IN THE LABORATORY...

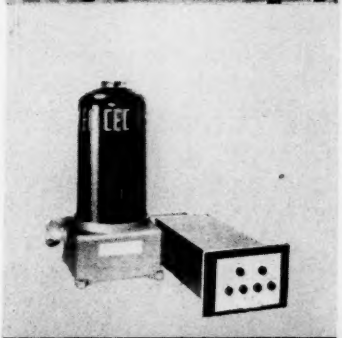
Choose from CEC's Line of Chromatographs

The new 26-014 Analyzer is designed to be used with the 26-002 Control Module also used in CEC's 26-201A Laboratory Chromatograph. These two modules make a complete high-temperature chromatograph. The 26-014 can also be combined with the complete 26-201A, to provide an economical laboratory team (1 control unit and 2 analyzers) which is the equivalent of two different chromatographs—one analyzer for components requiring high temperatures and the other for use at temperatures up to 200°C.

CEC's versatile 26-201A Chromatograph is a proven instrument possessing both speed and superior reproducibility. It operates at temperatures up to 200°C and features an exclusive thermostatted pre-cut column which eliminates any chosen portion of the heavier sample fraction from the analysis of a complex mixture—thus greatly reducing analysis time.



FOR RELIABILITY IN THE PROCESS PLANT... No process instrument on the market can surpass the reliability and precision of CEC's 26-202 Process Chromatograph. The 26-202 provides tailor-made solutions to application problems through continuous variable attenuation, automatic stream switching, and automatic zero standardization. Multiple columns with pre-cutting reduce analysis time. Reproducibility of sample volume is better than ±0.5%.



WRITE FOR THESE BULLETINS:

High-Temperature Analyzer	CEC 1847-X1
Laboratory Chromatograph	CEC 1831-X13
Process Chromatograph	CEC 1836-X31

Or contact your nearest CEC sales and service office.

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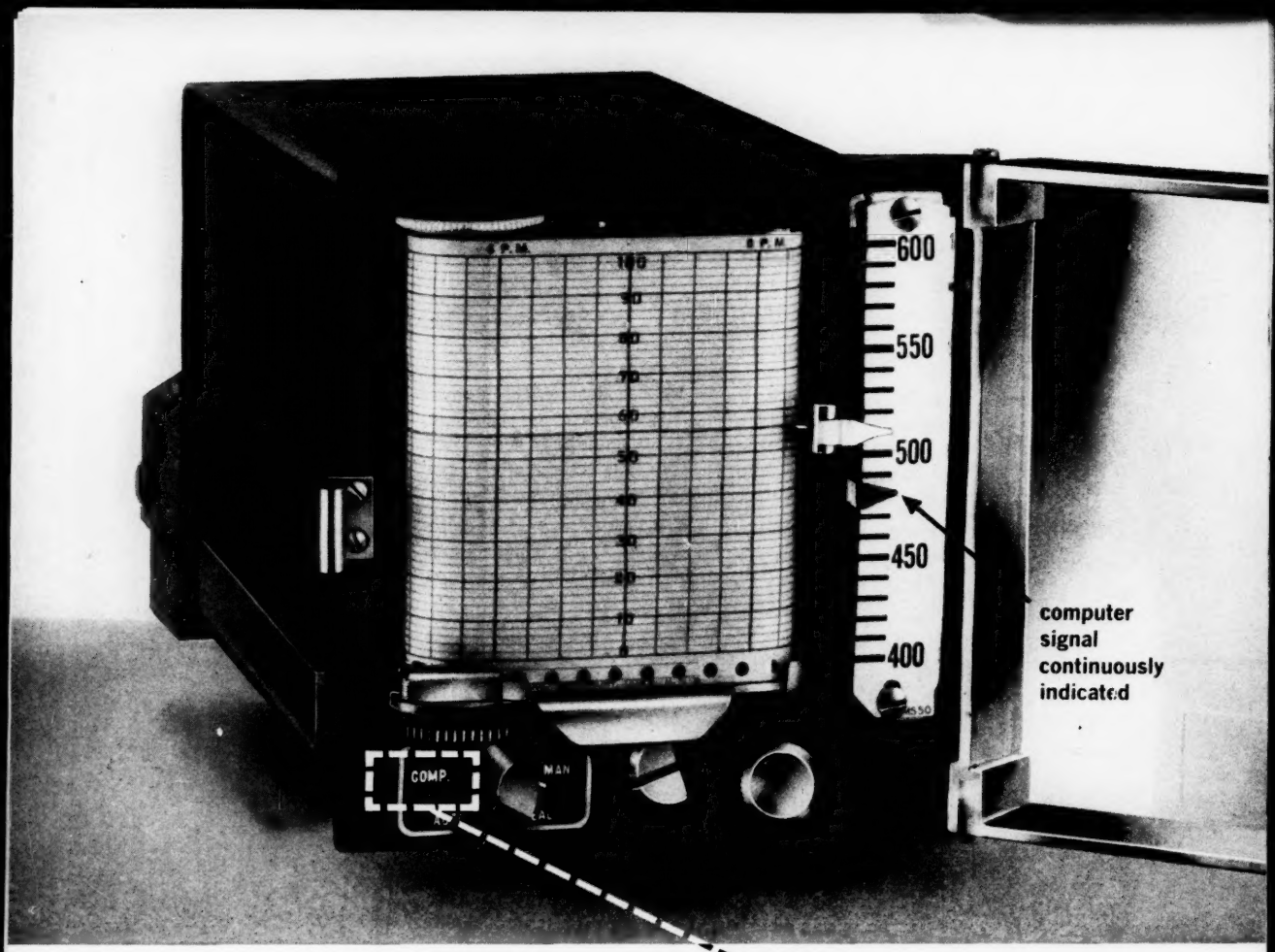
OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

For more information on Analyzers circle **148** on inquiry card.
For more information on Chromatographs circle **13** on inquiry card.



World's first **computer-controlled** petroleum refinery unit will use **Bristol** control stations. New Bristol Metagraphic pneumatic receivers were specifically designed to meet requirements of **computer-controlled processing.** Write for full information.

BRISTOL TRAIL-BLAZERS IN PROCESS AUTOMATION
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS
113 Bristol Road, Waterbury 20, Connecticut

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trends

Electronics industry market total was $9.6 billion in 1955, $11.08 billion in 1956, and $13.68 billion in 1957 reports EIA. Industrial and commercial electronic markets were $750 million in 1955; $950 million in 1957; $1.3 billion in 1957. Military electronics (sales to government) were $2.4 billion in 1955; $2.7 billion in 1956; $3.9 billion in 1957.

Battery market in USA (primary and secondary) in 1957 was $500 million, reports Morehouse of RCA. About 64% is for secondary cells; about 36% primary cells. About 90% of the dry primary cells are zinc/manganese-dioxide (Leclanche)cells.

First full-scale study of any sizeable portion of the frequency spectrum in 12 years has been made by FCC. This is study of frequency allocations above 890 Mc—which include 6 bands now allocated to Industrial, Scientific, and Medical (ISM) allocations. General Electric manager W. Morlock testified that "present spacing barely meets minimum requirements for . . . ISM services." As frequencies above 800 Mc cannot be controlled by quartz crystals, as in lower frequencies, narrowly controlled frequency operation in these ISM bands would increase equipment costs tremendously.

Capital required per worker in the industrial world has been growing steadily. In the Du Pont Company, for example, the investment per employee has doubled in the last 10 years—from $13,000 per employee in 1947 to $27,000 in 1957. For each employee in a new plant today, investments up to $100,000 may be required.

National Academy of Sciences-National Research Council has been petitioned by the Council on Documentation Research, Western Research University, to examine the need for a National Information System (abstraction, indexing, etc.). Impetus was given by the achievements of the Russian Institute of Scientific Information of disseminating technical information to technical workers in the Soviet Union.

Wind, tidal, and solar sources of electric power generation reveal discouraging economic picture. No significant dramatic developments are expected within decades. Nuclear energy is much more promising. Atomic-powered generating station can now be operated for only a third more than conventional power plants (fuel costs would be 7-8 mils/kw-hr, compared with 5-6 mils/kw-hr for conventional plant operating on fuel costing 40¢/million BTU).

In 1956, 40 million persons in USA received some type of formal education; expected to increase to 52 million by 1965. Total spent by public school systems in 55-56 school year was $11 billion, including $2.6 billion for new facilities. Total spent by colleges was $2.4 billion, including $0.5 billion for new construction. More than 7.5 million persons in USA are now college graduates, compared to 5.5 million in 1950.

There are now 35 reactors either in operation or under construction in the United Kingdom for research, testing and power production. Certain civil nuclear power reactors now in construction or design are being modified so that plutonium produced as a byproduct is suitable for military purposes (nuclear weapons).

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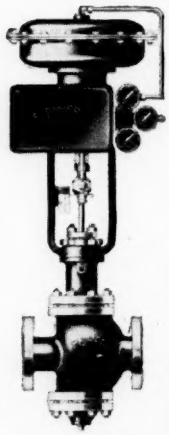
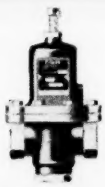
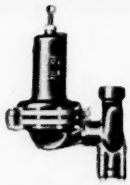


Type 657-A with 3500 Positioner

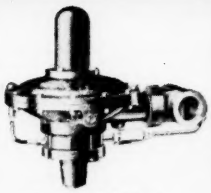
Type 4150 and 4160 Wizard II Pressure Controllers



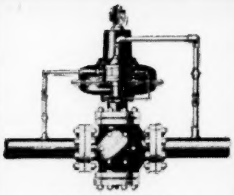
Type 95-H Pressure Reducing Valve



Type 630 "Big Joe" Field Regulator



Series 99-I Multi-Purpose Gas Regulators



Series 298T Gas Regulators

Type 655-A Pressure Regulator

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD . . . CHANCES ARE IT'S CONTROLLED BY . . .

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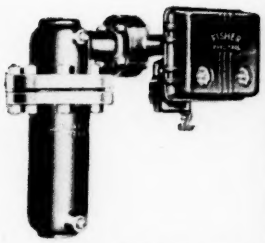
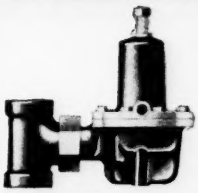


Series 2500-249 and 2500-259B Level-trols Cage Sizes 14" and 32"



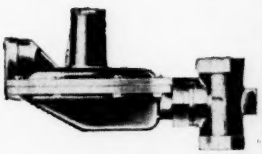
Series 620 and 621 Farm Tap Regulators

Series 67FR Combination Filter Regulator

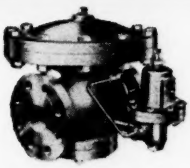
Yes, now you can shop by phone, wire or TWX (Marshalltown 578 or 579) and expect shipment of the equipment illustrated at left in a matter of hours. Now that Fisher Control Valves and Regulators are as readily available as your supermarket groceries, you can meet your emergency needs quickly. Fisher carries a stock of the popular and standard size control valves, displacement type liquid level controllers, pressure regulators and gas regulators on the "supermarket" shelf at all times. The offices in red maintain a wide selection of Fisher equipment in their own inventory.

New items will be added from time to time as needed. Each Fisher representative receives a weekly list of all available types and sizes.

Now, for emergency needs contact either the Fisher representative or the Fisher home office. Your order will be en route within 36 hours (except Saturday and Sunday) after it is received in Marshalltown.



Series S100 and 730 Service Regulators



Type 92B Pilot Operated Steam Reducing Valve

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news

Operating Guide Computer Goes On-Line

PHILADELPHIA, PA.—Leeds & Northrup and Esso have announced that an Operating Guide Computer System—the first installation of its kind in the process industries—has been successfully placed on-line at a catalytic cracking unit at Esso's Baton Rouge Refinery. Engineered and constructed by Leeds & Northrup Company,

the system measures 160 process variables of which 27 are computed operating guides such as catalyst circulation rate, carbon burning rate, material balance, etc. The system incorporates a Royal Precision LGP-30 general purpose digital computer. In addition to calculating operating guides, the system prints out off-normal conditions, and furnishes on-demand, hourly, and daily log sheet summaries of process operation.

Esso's project coordinator states that the system is not only expected to enable the operators to improve process performance, but also will be used to develop techniques for ultimately "closing the loop."

Evaluation of Extensometer-Recorders

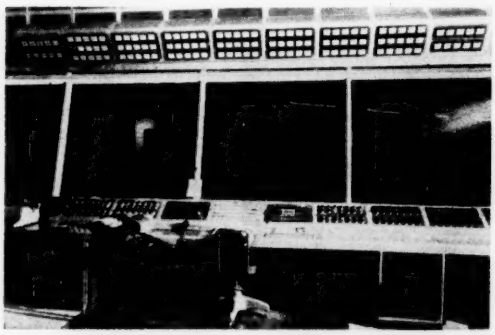
WASHINGTON, D. C.—Data on the accuracy of equipment producing autographic stress-strain records of tensile tests were recently released by the National Bureau of Standards. They included calibration of stress and strain coordinates, also measurements of expansion of graph paper in humid weather. An interferometric comparator was used to check the strain coordinate. The load coordinate was calibrated by comparing the testing machine indicator with the recorded load shown on a recorder mounted on the testing machine. By preventing the drum from turning, a record of the load only was made. Errors introduced by humidity were found to be quite significant inasmuch as (for example) a 40% change in relative humidity changed the length of the paper across the grain by 0.6 to 0.7%. The study revealed that the stress-strain recorder is a reasonably accurate instrument suitable for the type of tests in which it is employed.

Acrylic "Heart" for Electrolytic Analog Computer

NEW YORK, N. Y.—A sheet of acrylic only 3 feet by 5 feet and one inch thick, with 7,920 holes (accurately located and drilled on 0.5″ centers, concentric to each other within plus or minus 0.002″) is the "heart" for an analog computer to be used by Pratt & Whitney Aircraft Division. The computer uses electric current and voltage in an electroytic liquid to simulate conditions of heat flow and temperature in the corresponding locations of a nuclear reactor. Nuclear Development Corp. of America designed the unique computer for that purpose, and Comco Plastics solved the problems associated with drilling the plate.

Alarm System for Shopping Center

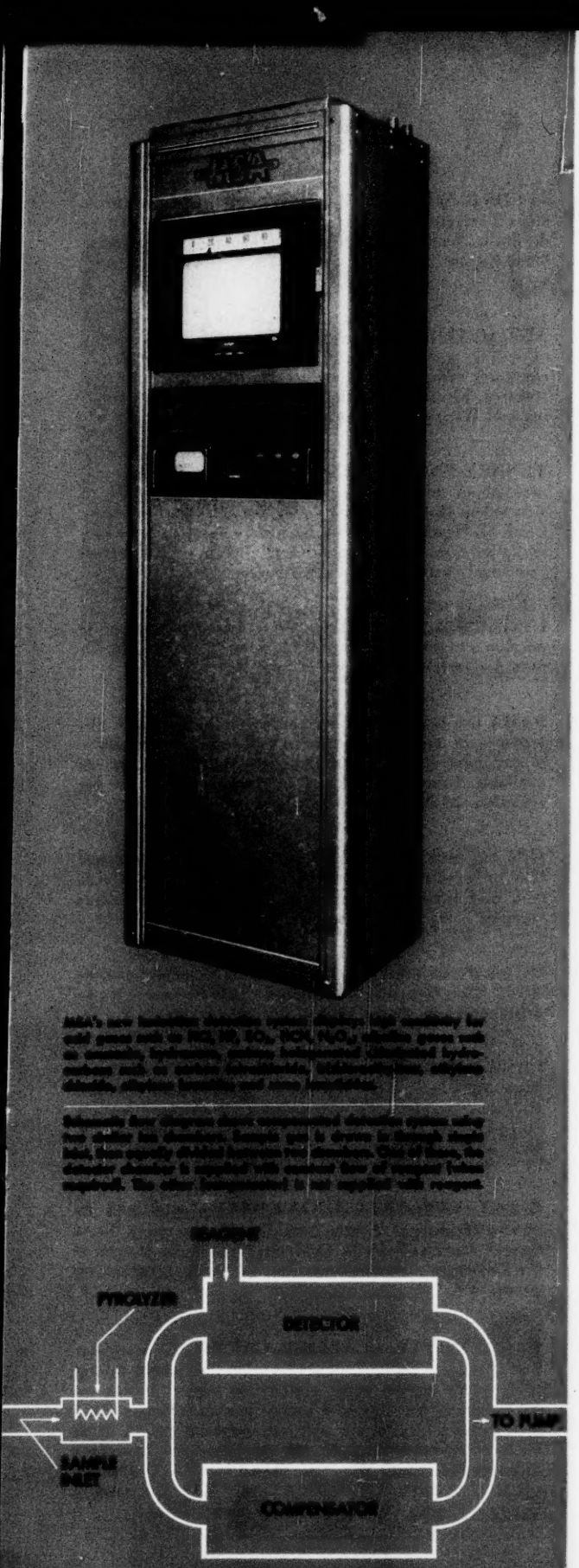
CHICAGO, ILL.—The new $20-million, 670,000-sq ft Southdale Shopping Center, just outside Minneapolis, includes a unique "nerve center" in its 75-store unit where aural and visual alarms monitor disturbances such as fire, burglary or machinery malfunction. A network of



165 annunciators, designed and installed by Scam Instrument Corp., allows the centralized "protection office" to send out coded messages over loudspeakers, which are strategically distributed over the whole area. Patrolling guards investigate and report back by telephone within 60 seconds. Savings accrued from machinery repairs, fire detection (since the opening in November, 1956, 22 fires have been spotted!), intrusion protection, and the fewer guards required, have almost paid for the installation in less than two years.

ASTM Holds 61st Annual Meeting

BOSTON, MASS.—This city was the place of the 61st Annual Meeting of the American Society for Testing Materials, held June 22-27, 1958. A recorded attendance of 2988 for the technical program made the meeting the largest in the Society's history. In addition, there were 42 technical sessions and over 800 technical committee meetings. Professor Kenneth B. Woods, Head, School of Civil Engineering, Purdue Uuniversity, was elected president for one year.



New M-S-A® Ionization Chamber detects airborne and process contaminants in the range of parts per billion

Application: air pollution studies and process monitoring

Problem: continuous, more sensitive measurement of toxic gases or vapors in traces as small as a few parts per billion

Solution: MSA's new ionization method of gas detection

MSA has been asking questions and coming up with the right answers in the field of gas analysis for over 30 years. Latest result of this probing inventiveness is a simplified ionization method of gas detection.

Principle of the M-S-A Ionization Chamber is unique, indeed. It measures electrically, in a specially designed ionization chamber, any decrease in the conductivity of ionized gas samples caused by removal of ions by the contaminant being measured. A radioactive material in the chamber produces continuous ionization.

Gas to be detected enters the chamber with a sensitizing reagent. Said gas may react chemically with the reagent to form sub-micron particles. Or, if the gas is electronegative, in a non-electronegative process gas, it may be detected without the need of additional sensitizing means.

Various sensitizing techniques assure a wide range of selectivity. Already, this new instrument can detect a large number of gases. The number increases as new sensitizing techniques are developed.

An MSA Instrument Specialist would be pleased to discuss in detail the materials which this device detects and measures so sensitively. Ask us for this man's name. And write us for descriptive literature.

INSTRUMENT DIVISION

MSA

Mine Safety Appliances Company
Pittsburgh 8, Pennsylvania

For more information circle **16** on inquiry card.

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News Bits

LEEDS & NORTHRUP trained specialists will speedily and effectively handle equipment sent back for repair to the Phila. factory, thanks to a 4-echelon Factory Instrument Repair Service now available to L&N instrument users.

ALWAC CORP. has scheduled a comprehensive series of spring and summer training courses in the use of electronic computers for business, industry, and scientific research. Elementary Coding, Executive Seminars, Soldering and Wiring will be among classes offered.

TENNEY ENGINEERING announces design and manufacture of unique environmental test chambers, constructed so that equipment under test (Sperry Gyroscope Co. B-58 Hustler) can be subjected to extremes of shock and vibration. The chambers contain an environmental "package" within a larger environmental chamber.

DIGITRON, INC., announces receipt of a contract to develop a high-speed electronic function plotter for Holloman Air Development Center.

SAMA has issued a Tubing Standard which lists 81 different sizes and wall thicknesses of rubber and plastic tubing most commonly used in laboratories. Copies are available (free) from Scientific Apparatus Makers Association, 20 N. Wacker Dr., Chicago 6, Ill.

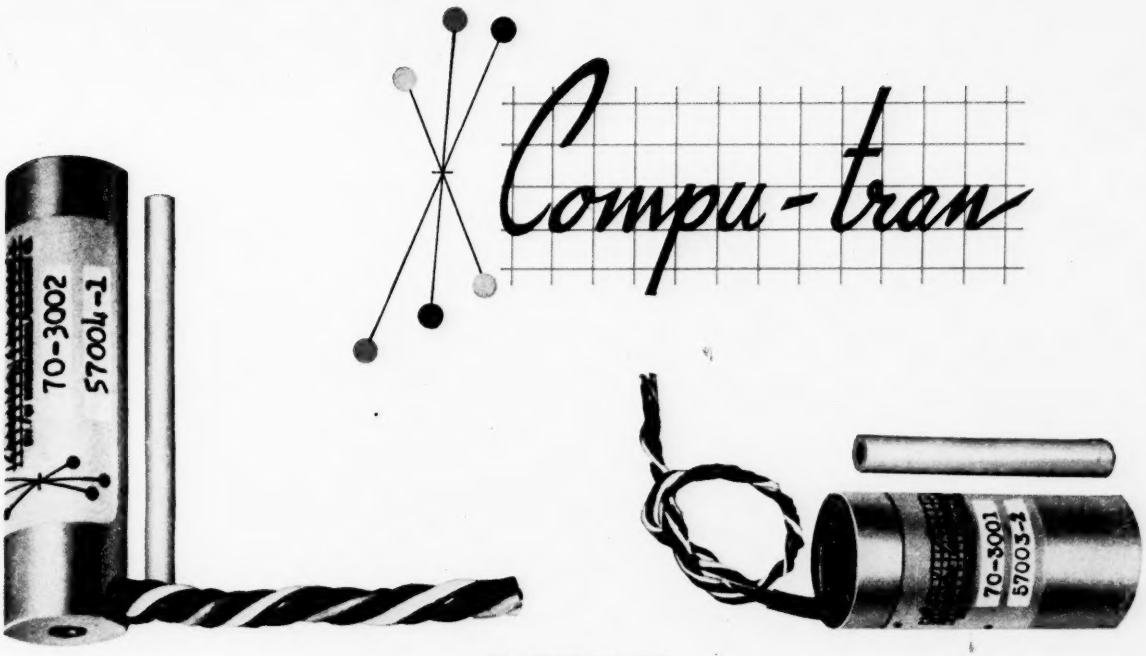
IBM has installed a RAMAC 305 at Norwich Pharmacal Co. for handling the company's billing, production control, and inventory control on 250,000 annual orders received from 50,000 customers.

RCA has concluded an agreement with Siemens & Halske AG of West Germany to distribute S&H electronic measuring apparatus in the USA.

CBS—HYTRON SALES Corp. has been running a home-study course on transistors. Applications for this 10-lesson course with correction and advisory service (fee: $25.00) should be directed to the company at 100 Endicott St., Danvers, Mass.

WEST VIRGINIA UNIVERSITY will hold its eighteenth Annual Appalachian Gas Measurement Short Course August 25 to 27. Address Prof. R. E. Hanna at the University, Morgantown, W. Va., with program requests, etc.

BARRETT DIV. of ALLIED CHEMICAL is supplying "Plaskon" nylon to extruders for instrument tubing designed to replace other plastic and copper tubing on panel boards etc. Nylon is tough, has great temperature and abrasion resistance, and can be color coded. It is 50% cheaper than copper per running foot. Extruders include: Danielson Mfg. Co. (Conn.), M & Q Plastics (N. J.), Polymer Corp. (Pa.), Sonlo Mfg. Co. (Ind.), Sunlight Plastic (Wis.), Samuel Moore (Ohio).



IRC SERIES 70-3000

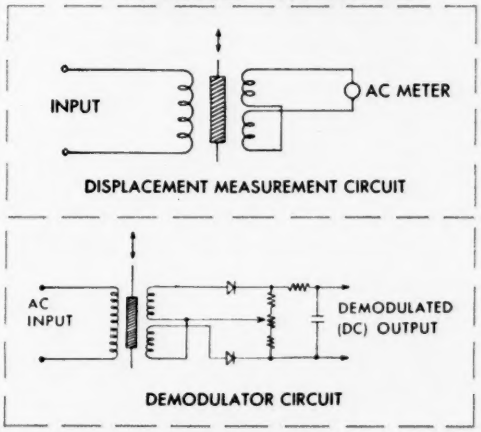
DISPLACEMENT TRANSDUCER

The IRC Displacement Transducer offers many new advantages, including lower cost. Its higher sensitivity and 0.1% linearity is specially suited to military instrumentation applications. The output is completely stepless and null voltage is 0.25% or less of total output. In addition, the output of standard IRC Displacement Transducers is high . . . 2 MV/Volt Input/Mil; all offer high output voltage in relation to size. Input voltages can be obtained up to 110 v. AC.

Compu-Tran Displacement Transducers show high resistance to moisture and shock . . . are available in 23 standard and sub-miniature sizes with a temperature range of −65 to +225°F. Also, IRC's Compu-Tran Displacement Transducers are the only units available completely encapsulated in a protective unit.

Designers of accelerometers and other measuring, indicating, gaging and process control devices will be especially interested in Compu-Tran Bulletin R-3. Write for your copy today.

TYPICAL CIRCUITS



NOTE—Special units available as follows:
- Long linear range unit (4" range in 6" shell)
- Power unit (110 volts, output 10 to 12 volts)
- Temperature compensative unit (insensitive to changes through range of −65°F to +225°F)

IRC

INTERNATIONAL RESISTANCE COMPANY

COMPUTER COMPONENTS DIVISION

Dept. 453, 401 N. Broad St., Philadelphia 8, Pa.

In Canada: International Resistance Co., Ltd., Toronto, Licensee

For more information circle **18** on inquiry card.

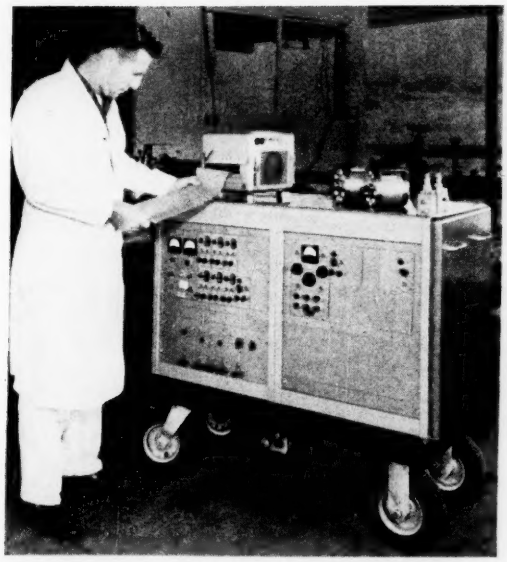
Unretouched Visicorder Record—actual size

Wyle Laboratories in El Segundo, California, have used a battery of four Visicorder consoles like the one shown below to run a series of tests on a vital missile component. In the Wyle test project the unique Visicorder consoles are easy to operate. Most parameters are low frequency, requiring response on the order of 5 to 60 cycles.

The two calibrator control panels in each of the Visicorder consoles accommodate 10 plug-in balance and matching units—designed to match tachometer generators, pressure transducers, thermocouples, expanded-scale voltmeters, etc., to the Heiland galvanometers.

Dick Johnson, Instrumentation Branch Head at Wyle Laboratories, says. "This system, I feel, is one of the most efficient instrumentation consoles in operation. Set up and calibration time has been reduced by the use of Visicorders by approximately fifty percent. This is due to the simplicity of operation and trouble-free performance. There are no inking pens to clean, high-gain amplifier maintenance, and so on, and we can also use these consoles together to form systems of more than six channels."

# of a missile component



Tom Jackson, Wyle engineer, examines Visicorder record

The HONEYWELL VISICORDER is the first high-frequency, high-sensitivity direct recording oscillograph. In laboratories and in the field everywhere, instantly-readable Visicorder records are pointing the way to new advances in product design, rocketry, computing, control, nucleonics . . . in any field where high speed variables are under study.

To record high frequency variables—and monitor them as they are recorded—use the Visicorder Oscillograph. Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

Reference Data: Write for Visicorder Bulletin
Minneapolis-Honeywell Regulator Co.,
Industrial Products Group, Heiland Division
5200 E. Evans Ave., Denver 22, Colo.

Honeywell

Industrial Products Group

For more information circle **19** on inquiry card.

EPLAB

PYRHELIOMETER
For the Measurement of SOLAR RADIATION

Eppley Pyrheliometers are used for solar radiation measurements at ninety-eight weather stations in the continental United States, Canada, Alaska, Greenland, Iceland, Caribbean Sea, and the Pacific Ocean. Sixty-two of these stations are under the direction of the United States Weather Bureau.

The Eppley Pyrheliometer was adopted as standard equipment by the Weather Bureau after considerable experimentation. It was found to be the best instrument so far tested by the Bureau.

Used in conjunction with a suitable recorder, the Eppley Pyrheliometer will provide an accurate and reliable record of total solar and sky radiation on a horizontal surface.

Bulletin No. 2 on Request

THE EPPLEY LABORATORY, INC.

Scientific Instruments

2 Sheffield Ave.

Newport, Rhode Island U. S. A.

For more information circle **20** on inquiry card.

stock report

Any further information concerning any of the following issues may be obtained from the Research Department, Bache & Co., 36 Wall Street, New York 5, N. Y.

American Stock Exchange:

Price Range For 1956 Thru 8/15/58

	HIGH	LOW	Price as of 8/15/58
American Meter	36	27 5/8	35 1/2
Arc Equipment	18 1/2	13 3/4	18 1/8
Barry Controls "B"	8 7/8	4 3/8	8
Belock Instruments	11 3/4	7 3/8	10 3/4
Benrus Watch	6 7/8	4 7/8	5 3/8 - 5/8 (1)
Breeze Corp.	6 1/2	5 1/8	6
Clark Controller	19 1/2	14 7/8	16 3/4
Clarostat Mfg.	3 3/4	2 7/8	3 3/8
Clary Corp.	4 3/4	2 7/8	4
DuMont Laboratories	5 5/8	3	4 1/4
Dynamics Corp. of America	4 1/4	2 7/8	3 7/8
Electronics Corp. of America	8 3/8	6 3/8	8 1/4
El-Tronics	3 1/8	1 5/8	2
Fairchild Camera & Instrument	31 5/8	19 1/2	25
Globe-Union	17 1/4	14 5/8	15 5/8
Hazeltine Corp.	42 3/8	30 1/2	40
International Resistance	4 5/8	3 3/4	4 1/8
Lear, Inc.	7 1/2	4 1/4	7 1/4
National Research	17 3/8	12 7/8	15 3/4
Neptune Meter	27 1/4	19 1/2	26 1/2
New Haven Clock	3 1/4	7/8	1 3/8
Norden-Ketay	6 7/8	2 3/4	3 1/4
Nuclear Corp. of America	1 1/2	1	1 1/8
Pneumatic Scale	36	16 1/2	29 3/4-31 3/4(1)
Raven Corp. of America	6 3/4	3 3/4	5 7/8
Servomechanisms	11 1/8	6 5/8	10
Wallace & Tiernan	27 1/4	24	25 5/8
Waltham Prec. Instrument Co.	1 1/2	13/16	1 1/8

1) Not Traded - Bid, Asked

New York Stock Exchange:

Price Range For 1956 Thru 8/15/58

	HIGH	LOW	Price As of 8/15/58
ACF Industries	45 1/2	37 1/8	44
Aeroquip Corp.	21 7/8	16 7/8	19 1/4
Allis Chalmers	26	22 1/8	27
American Chain & Cable	46 1/2	39 1/2	46 1/4
American Machine & Foundry	39 3/8	32 1/4	38 1/8
American Machine & Metals	57 1/2	47 1/2	57
American Optical	39 1/8	35	35 1/4
American Tel. & Tel.	184	167 7/8	181 1/4
Beckman Instruments	25 3/4	18 1/8	23 5/8
Bell & Howell	71 1/2	42	68 3/4
Bendix Aviation	59 1/4	44 1/2	57
Boeing Airplane	47 3/4	34 1/8	45 1/8
Ballard	17 1/4	10	16 1/8
Bulova Watch	14	9 3/4	13 1/8
Burroughs	36 7/8	27 5/8	36
Carborundum	36 3/4	30 7/8	34 7/8
Cincinnati Milling Machine	40 1/4	27	37 3/4
Clevite	20 3/8	15 3/4	19 7/8
Columbia Broadcasting "A"	34	24 1/2	33 1/4
Consolidated Electrodynamics	35 1/2	27 7/8	32 1/8
Consolidated Electronics	26 3/4	19 1/2	24 1/4
Cornel Dubilier	18	12 3/4	17 3/4
Corning Glass	94 1/2	74 5/8	89 3/4
Curtiss-Wright	29 1/2	20 5/8	27 1/2
Cutler-Hammer	57 3/4	40 1/2	57 3/8
Daystrom	36 1/2	30	33
Douglas Aircraft	74 7/8	54 1/2	60
Eastman Kodak	119 7/8	97 1/8	116
Eaton Manufacturing	51	38 1/2	51
Electric Auto Lite	36 3/8	25	35 5/8
Elgin Watch	9 3/4	6 3/4	7 7/8
Emerson Electric	40 1/4	29	39 3/8
Food Machinery & Chemical	63	47 1/2	62
Gamewell	31	20 1/2	29 1/2
Garrett	44 1/2	27	41 1/2
General Dynamics	65 3/4	55	60
General Electric	64 7/8	57	64
General Instrument	9 3/8	4 5/8	8 7/8
General Mills	81	60 1/4	79 5/8
General Precision Equipment	41	28 1/2	38 3/4
General Railway Signal	31 1/8	21 1/8	29
General Telephone	53 3/8	40 3/8	51 3/8
General Time	24 3/4	16 5/8	23 3/8
General Tire & Rubber	30	22 1/4	27
International Bus. Machines	377 1/2	300	370
International Tel. & Tel.	41	29 1/4	40 1/8
I-T-E Circuit Breaker	42	36 1/8	40 1/2
Litton Industries	53	35 7/8	50
Lockheed Aircraft	54 1/8	38 3/8	52 3/4
Magnavox	39 1/4	30 1/4	36 1/2
Mallory	30 1/4	23 5/8	29 1/4
Minneapolis-Honeywell	99 3/4	76	96 3/4
Minneapolis-Mining & Mfg.	94 1/4	73 1/2	90 3/8
Motorola	43 3/4	35	43 1/4
National Acme	54 1/2	43 7/8	51
National Cash Register	71 1/2	50 1/2	68 1/4
North American Aviation	36 1/4	25 5/8	34 1/2
Northrop Aircraft	27 1/2	22 1/8	26 7/8
Otis Elevator	56	40 1/4	54 3/8

Continued on page **1476**

BRUSH
RECORDER MARK II

At last!

New Oscillograph Package

AS "IDIOT-PROOF" AS YOU'VE HOPED FOR

- **Built-in amplifiers**
- **Permanently calibrated**
- **Instant paper loading**
- **"White glove" writing system**

IMMEDIATELY AVAILABLE FROM STOCK $1350

Factory branches, service and warehousing at Arlington, Va., Boston, Cleveland, Los Angeles and Seattle; engineering representatives in all key locations.

brush INSTRUMENTS
DIVISION OF
CLEVITE CORPORATION
3405 PERKINS AVENUE CLEVELAND 14, OHIO

For more information circle **21** on inquiry card.

MARSHALLTOWN

THE RIGHT GAUGE FOR YOUR SPECIFIC NEEDS

Available in a wide variety of general purpose and special purpose gauges in pressure ranges to meet your specifications in every particular.

- PRESSURE
- VACUUM
- COMPOUND
- ALTITUDE
- COMBINATION
- DIAPHRAGM
- HYDRAULIC
- AND SPECIAL PURPOSE GAUGES
- DIAL THERMOMETERS (Vapor Tension or Bi-Metal)

WRITE TODAY FOR COMPLETE INFORMATION

MARSHALLTOWN MFG. COMPANY
MARSHALLTOWN 3, IOWA

For more information circle **22** on inquiry card.

New York Stock Exchange

Continued from page 1474

Philco Corp.	19 1/2	12 3/8	18 3/4
Radio Corp. of America	36 1/2	30 1/4	35
Raytheon	35 1/2	21 1/2	33 1/8
Reliance Electric	41	31	40 7/8
Rheem Mfg.	15 1/2	10 1/2	14
Robertshaw-Fulton	26 1/2	22 1/4	26
Royal McBee	21	16	19 1/4
Sangamo Electric	34 3/4	25	26 1/2
Sperry Rand	21 1/8	17 1/4	20 1/4
Square D	26 1/4	20 1/8	24
Standard Coil Products	10 3/8	6	9 3/4
Starrett (L.S.)	74 3/4	57	67 1/2
Stewart-Warner	39 1/8	29	37 3/4--38¢ (1)
Sylvania Electric	41 1/8	31 1/2	39 3/4
Telautograph	7 7/8	3 3/4	6 3/4
Texas Instruments	50 1/2	26 3/4	49
Thompson Products	50 3/4	41 3/8	56 5/8
Tung-Sol Electric	29 3/4	23 1/4	27 7/8
Underwood Corp.	22	12 7/8	18 7/8
Union Carbide Corp.	110 1/2	83 7/8	106 3/8
United Shoe Machinery	45 1/2	32	43 5/8
Western Union	24 1/4	15	24
Westinghouse Air Brake	26 3/8	17 7/8	25 1/2
Westinghouse Electric	65 1/2	55 1/2	61 1/8
Worthington Corp.	61 7/8	45 1/4	59 3/4

(1) Not Traded - Bid, Asked

Over-The-Counter

	Quotation as of 8/15/58	
	BID	ASKED
Aerovox Corp.	4	4 1/2
Aircraft Radio Corp.	20 1/2	21 1/4
Argus Corp.	23 3/4	24 5/8
Bite-McCullough	28 1/2	29 1/2
Electronics Associates	41 1/2	42 3/4
Erie Resistor Corp.	7 1/4	7 3/4
Fisher Governor Company	14 1/2	15 1/2
G.M.Giannini	14 3/8	15 1/4
Industro Transistor	1 5/8	2
Liquidometer Corp.	5 3/4	6 1/4
W. L. Maxson	6 3/8	7
Penn Controls, Inc.	16 3/4	17 3/4
Speer Carbon, Inc.	25 1/4	26 1/4
Sprague Electric	33 1/2	34 3/4
Taylor Instrument	28	29
Telecomputing Corp.	5 1/4	5 3/4
Topp Industries	9 1/8	9 5/8
Varian Associates	25 3/4	26 3/8
Vitro Corp. of America	16 1/4	17 1/8

CARL ZEISS

WEST GERMANY

Look for this world-famous trade-mark on scientific instruments

A few outstanding instruments embodying the traditions of this trade-mark:

LARGE TOOLMAKER'S MICROSCOPE
INTERFERENCE MICROSCOPE
LIGHT SECTION MICROSCOPE
OPTICAL DIVIDING HEAD
CIRCULAR DIVISION TESTER
ULTRAPHOT II for incident illumination
PHOTOMICROSCOPE for incident illumination with automatic exposure-setting device
METALLURGICAL MICROSCOPE
STEREO MICROSCOPE
EPI MICROSCOPE
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Write for free, detailed specifications on equipment of interest to you

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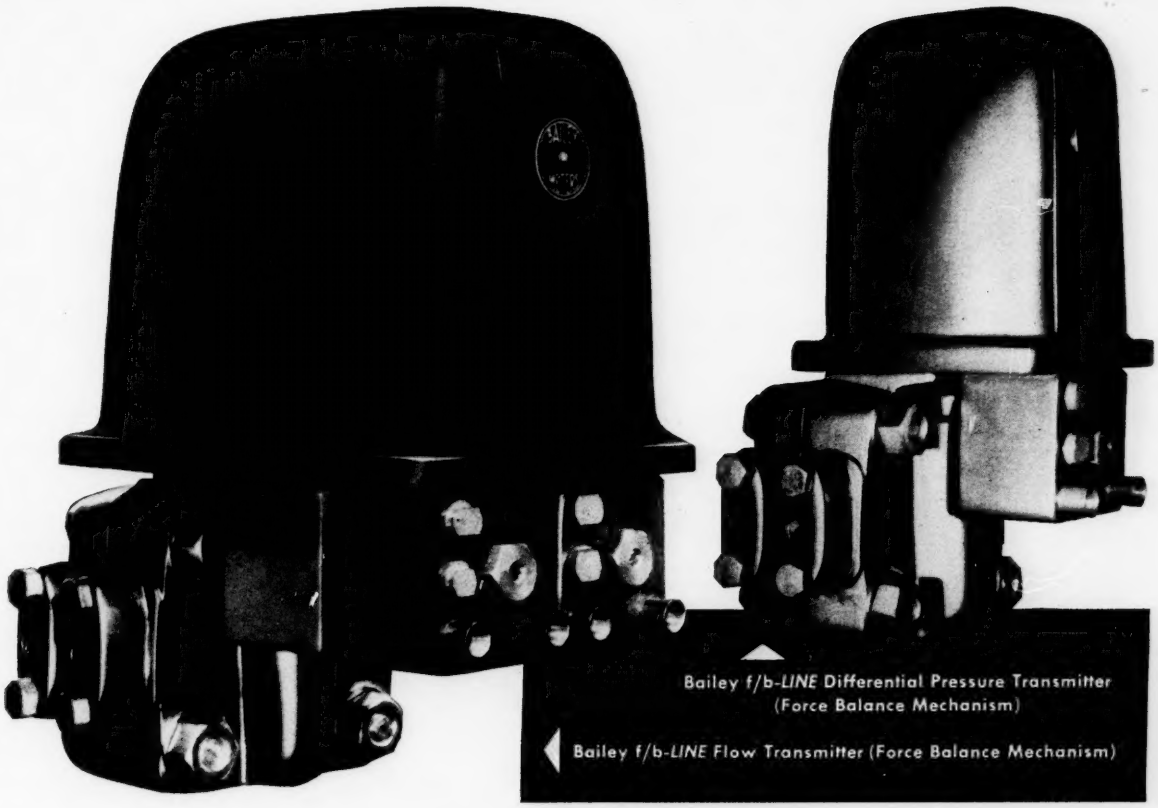
485 FIFTH AVENUE, NEW YORK 17, N. Y.

GUARANTEED UNINTERRUPTED REPAIR SERVICE

For more information circle **23** on inquiry card.



Bailey f/b-*LINE* Differential Pressure Transmitter (Force Balance Mechanism)

Bailey f/b-*LINE* Flow Transmitter (Force Balance Mechanism)

Two new Bailey *f/b-LINE* Transmitters

permit new accuracy in measuring flow and differential pressure

Pneumatically transmits rate of flow—or differential pressure—measurements to indicating, recording, and/or controlling equipment at remote stations. Transmitters consist of a diaphragm measuring mechanism and a force balance pneumatic transmitting unit.

APPLICATION

For steam, water, air, gases and other fluids producing differentials across primary elements from 0-2 in. H_2O to 0-2000 in. H_2O at maximum service pressure of 50, 1500, and 5000 psig.

FEATURES

Transmits a Signal Directly Proportional to Rate of Flow. Uses receiver with uniformly-graduated chart or scale. Eliminates need for external square-root extractors or characterizers.

10 to 1 Turndown. Differential range of each diaphragm measuring element may be changed by factor of 10 to 1; e.g., 0-20 in. H_2O diaphragm may also measure 0-2 in. H_2O.

Screwdriver Adjustments. Range and zero adjustments readily accessible. Range may be changed with screwdriver adjustment.

Overpressure Protection. Protects against full service pressure applied to either side of diaphragm.

Fast Response. No viscous dampers needed, so speed of response is very fast.

Corrosion Resistant. For maximum differentials between 20 and 2000" H_2O, all parts in contact with process fluid may be stainless steel. No sealing fluids or sealing diaphragm required.

Good Stability. Reset type boosters give good stability with high gain.

Versatile Mounting. May be mounted on process piping, wall, or separate mounting pipe using same bracket.

For additional information, call your local Bailey District Office, or write direct. G46-1

See these new instruments at the ISA Show

Instruments and controls for power and process

BAILEY METER COMPANY

1041 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

For more information circle **24** on inquiry card.

K (STANDARD)

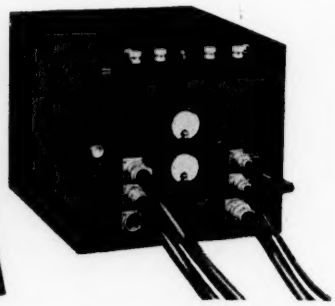
For Aircraft, Electronic, Instrument, Military, Missile, Industrial and Commercial Applications.

Standard K and RK...in straight and angle 90° plugs, wall mounting receptacles. Conduit and clamp entry types. 1 to 82 contacts in 213 different insert arrangements. 10-, 15-, 30-, 40-, 60-, 80-, 115-, and 200-amp. silver-plated brass contacts. High quality phenolic, melamine, and formica insulators. Cadmium-plated aluminum alloy shells. Flashover voltages: 1100 to 5000v 60cps ac rms.

connect with CANNON PLUGS

APPLICATION

Application of R and RK connectors on a recording oscillograph.



original aircraft, electronics, sound, and all-purpose line

KH, RKH
(HERMETICALLY SEALED)

For Use Under Critical Pressure and Leakage Conditions

Hermetically sealed connectors... with steel shells, steel contacts, and Canseal glass insulators, fused to shell and contacts. *True hermetic sealing.* Electro tin plating over cadmium plate over copper flash provides highly receptive surface for soldering and corrosion resistance.

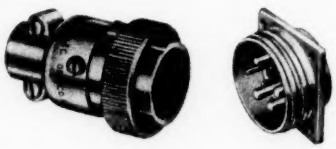
STEEL SHELL FIREWALL

For Open Flame Protection Against High Temperatures

FW and FWR Cannon K Firewall Connectors... available in straight and angle 90° plugs, wall mounting receptacles. Inserts of phenolic or fireproof inserts of glass-filled materials. Crimp type contacts. Cannon made the first firewall connector and continues the leader in this important field.

RECORDER CONNECTOR

For Telephone "Beeper" Connectors



SK-M7-21C...Widely used on two leading makes of telephone recorded connector units known as "beepers" because of the signal required by law in such recordings.

special acme thread • rugged construction • variety of coaxials • integral clamps

RK
PLUG AND RECEPTACLE

For Flush or Semi-Flush Mounting

RK plug and pin assemblies are equipped with an external threaded coupling nut which is the reverse of the standard K series. Note, RK will not mate with K's.

RLKL and LKL
(TV SWITCHING PANEL)

For TV Panel Switching

Quick Connect and Disconnect RLKL Plugs... designed for one-hand fast disconnect use on TV station program switching panels. Feature a quick coupling means. Latchlock secures plug to mated fitting (RLKL receptacle). Thumb pressure releases it.

K ACCESSORIES

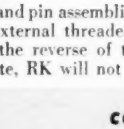
Straight and Angle 90° Junction Shells, Dust Caps, Bonding Rings, Gland Nuts, Clamps, Dummy Receptacles

Featuring High Quality Materials and Workmanship... Junction shells are designed to protect, shield, and carry wires through walls, panels or bulkheads to conduit. Dummy receptacles hold and protect plugs when not in use.

cannon plugs • standard of quality for the industry

TBF-K

For Carrying Circuits Through Bulkheads



TBF-K Bulkhead Connectors... feature a double-faced construction *allowing mating at both ends.* Pin inserts. Single piece shell. Five insert assemblies available.

Other Cannon Series... Mil. Spec. "MS" (full line) – External Power Connectors – Switching Types – dc Solenoids – Guided Missile Launching Connectors – Miniatures and Sub-Miniatures.

See "K" Bulletin for Engineering Data.

Please Refer to this Magazine or to Dept. 419

CANNON PLUGS

Where Reliability for Your Product Is Our Constant Goal

CANNON ELECTRIC COMPANY, 3208 Humboldt St., Los Angeles 31, California. Factories in Los Angeles; Salem, Massachusetts; Toronto, Canada; London, England; Melbourne, Australia. Manufacturing licensees in Paris, France; Tokyo, Japan. Contact our representatives and distributors in all principal cities. See your Telephone Yellow Book.

For more information circle **25** on inquiry card.

AT LAST .

A COMPLETELY

RELIABLE

all ELECTRIC

VALVE PO

NC CONTROLS

- TRANSISTORIZED
- SELF-LUBRICATING
- EXPLOSION-PROOF
- EASILY ADJUSTABLE
- MANUALLY OPERABLE
- LOW STAND-BY POWER
- UNIQUE BRAKING... prevents valve oscillation

Norwood's new all-electric positioner completely eliminates the need for auxiliary hydraulic or pneumatic valve actuating systems and operates from most standard electric controllers. A 1/40 h.p., 2-phase, induction-type electric motor drives the actuating shaft through a highly efficient self-lubricating gear train and ball-screw mechanism.

Stroke can easily be field-adjusted from ½" to 2". Shaft speed is .15 in./sec. Maximum thrust is 1000 lbs. and built-in limit switches prevent valve damage.

Shaft oscillation is effectively prevented by means of a unique, electro-mechanical braking system which prevents movement of the shaft unless the motor is energized or unless it is being operated manually. The combination of an anticipatory circuit with dynamic braking narrows the dead band and ensures repeatability of position to within ¼%. Stand-by power requirement is as low as 50 watts.

For further information, write for data sheet B158-3.

Norwood Controls Unit, Detroit Controls Division, 937 Washington St., Norwood, Mass.

AMERICAN-Standard PRODUCTS

AMERICAN-Standard

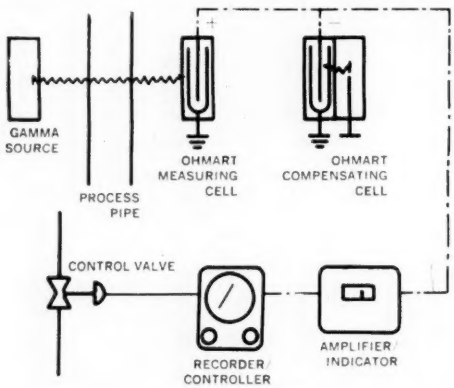
DETROIT CONTROLS DIVISION

For more information circle **26** on inquiry card.

briefs

Density Gaging With Gamma Radiation

All Ohmart equipment is based on a unique, patented Ohmart cell which converts gamma radiation energy directly into electrical energy. In both density and level measurements, a safely shielded source of gamma radiation is arranged so that its energy passes



through the pipe or vessel containing the liquid or slurry to be measured. The amount of radiation energy reaching the Ohmart cell is a function of the density or level of the material in the pipe. Cell electrical output is therefore proportional to material density. This output signal is amplified and fed to a recorder-controller. Departures from the optimum control point thus actuate the controls necessary to bring the process back to optimum density . . . (*From new* 6-*page Bulletin* 105-*C, The Ohmart Corp.,* 2236 *Bogen St., Cincinnati* 22. *Ohio*)

For this literature circle **201** on inquiry card.

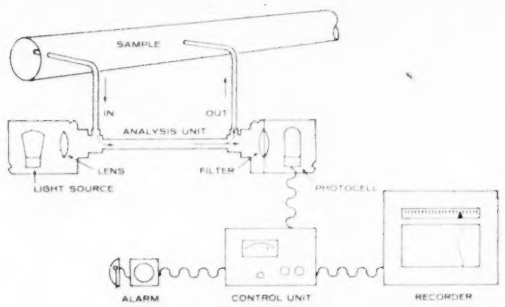
Automation Shares—A Mutual Fund

Nature of the Fund. Automation Shares, Inc. is an open-end investment company of the management type which seeks capital growth by diversifying and specializing its investments largely in companies participating in the manufacture, rental, installation or servicing of automation devices and equipment, or the design and development of automation equipment, processes, or systems. Automation cannot be authoritatively defined as it is a word which may have different meanings to different people. The term as used in the name of the Fund and in the statement of its investment policies is defined in this Prospectus under the title, "What is Automation?" . . . (*From new* 12-*page bulletin, Automation Shares Management Corp.,* 734 15*th St., N. W., Washington* 5, *D. C.*)

For this literature circle **202** on inquiry card.

Flow Colorimeter

The Model 77 Flow Colorimeter is a two-part instrument: The Analysis Unit, where the analysis is made, and the Control Unit, where the analysis is presented. Where a measurement of turbidity is desired, a sample of the process fluid continuously passes through the sample cell in the center of the single-beam analyzer (as shown in the diagram below). A

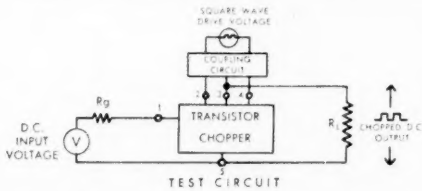


beam of light is passed through the sample stream and a color filter onto a phototube. The phototube measures the amount of light of a specific wave length region transmitted through the sample stream. Light will be absorbed in proportion to the concentration of solids or intensity of color in the sample stream. The signal from the phototube is amplified in the Control Unit to drive a direct-reading meter and, if desired, any standard potentiometric recorder or alarm circuit . . . (*From new* 4-*page Bulletin* 4000, *Beckman/Process Instruments Div., Fullerton, Calif.*)

For this literature circle **203** on inquiry card.

Transistorized Chopper

The Model 50 solid state chopper utilizes a matched pair of transistors which are alternately switched on and off. Although a single transistor can be used to accomplish the same function, the use of a matched pair connected in the proper manner has the advantage of a lower signal null in the order of tenths of a milli-



volt or less and also provides a much greater degree of drift stability over a wide temperature range . . . Since the solid state chopper is an inertialess device, extremely high chopping frequencies are obtainable. Chopping frequencies as high as several hundred kilocycles per second have been used for certain applications. Accordingly, the voltage to be modulated may be a time varying function somewhat slower than the chopping frequency . . . (*From new* 4-*page Bulletin "Solid-State Chopper Applications," Solid State Electronics Co., Van Nuys, Calif.*)

For this literature circle **204** on inquiry card.

2 NEW OHMITE® Precision Resistors

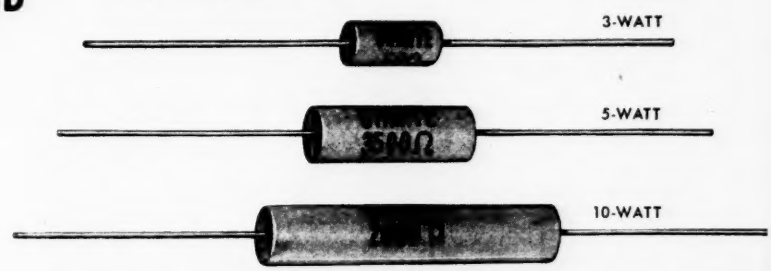
exceed Military Specifications

provide Low Temperature Coefficient of Resistance

NEW MOLDED WIRE-WOUND POWER TYPE

BULLETIN 153

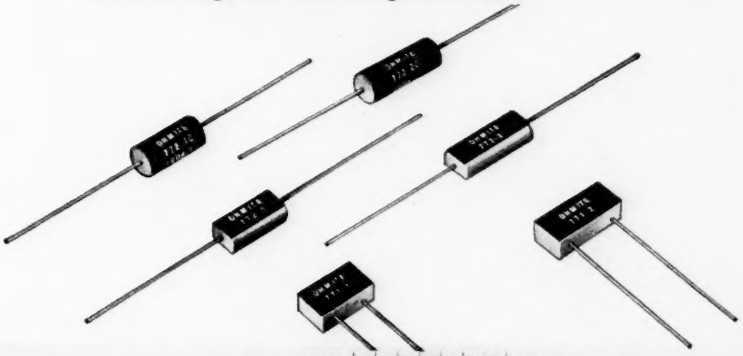
Ohmite Molded Precision Power Resistors are exceptionally high-quality units providing excellent performance. They are wound in a single layer on ceramic cores. Temperature coefficient of resistance is low, 0 ±20 ppm/°C. Tough, molded, silicone-ceramic covering—abrasion and moisture-resistant. Insulated units with high dielectric strength. Wide selection of resistance tolerances: 0.1%, 0.25%, 0.5%, 1.0%, and 3.0%. Uniform size—ideal for automated assembly. Designed to meet MIL-R-26C. Maximum resistance: 3-watt, 10,000 ohms; 5-watt, 25,000 ohms; 10-watt, 50,000 ohms.



NEW METAL-FILM TYPE

BULLETIN 155

Ohmite RITEOHM® Metal Film Resistors feature full ¼-watt rating at 150°C ambient. These new units may be used at *full rated wattage* in higher ambients than other types of precision film resistors. Rated at ½ watt at 125°C. Excellent high-frequency characteristics; standard temperature coefficient is 0 ±25 ppm/°C over a wide temperature range of —55°C to +190°C. A T.C. of 0 ±50 ppm/°C is also available at lower cost; long term load and shelf stability. Resistance range: two sizes provide over-all range of 25 ohms to 350K ohms. The smaller unit provides resistances from 25 ohms through 150K ohms; larger unit covers the range over 150K through 350K ohms.



RHEOSTATS • RESISTORS • RELAYS
TAP SWITCHES • TANTALUM CAPACITORS
R. F. CHOKES • VARIABLE TRANSFORMERS

OHMITE MANUFACTURING COMPANY
3615 Howard Street, Skokie, Illinois

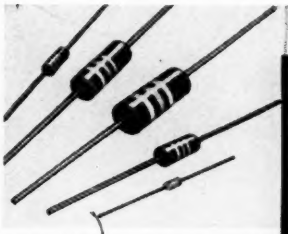
Be Right with OHMITE®
QUALITY Components

For more information circle **27** on inquiry card.

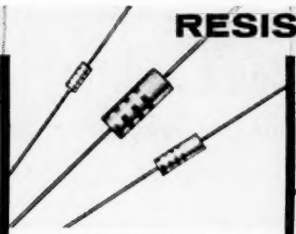
ALLEN-BRADLEY electronic components

The standard of quality for long life and dependable performance

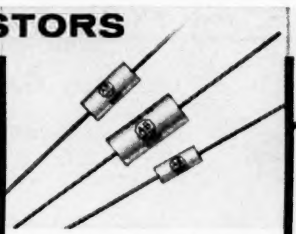
RESISTORS



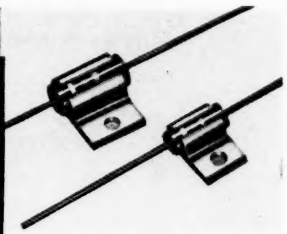
HOT MOLDED COMPOSITION RESISTORS—Quality standard of the industry. Rated at 70°C, in 2, 1, 1/2, 1/4, and 1/10 watts. Res. to 22 meg. Tol: 5, 10, and 20%.



HERMETICALLY SEALED in ceramic tubes. Solid, hot molded resistor. Less than 1% resistance change after 250 hr, 95% rel. hum., 40°C. Resistance values to 22 megohms.

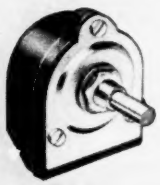


METAL GRID PRECISION RESISTORS—Hermetically sealed. Noninductive. 1, 1/2, And 1/4 watts at 100°C. Tolerances 0.1% to 1.0%. Temp coef. ± 25 PPM/°C.

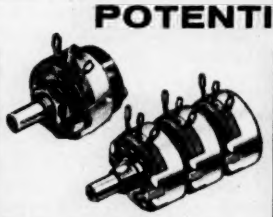


COPPER CLAD—Metal panel mounting, insulated composition resistor supplied in two ratings: 3 and 4 watts at 70°C, and 4 and 5 watts respectively at 40°C.

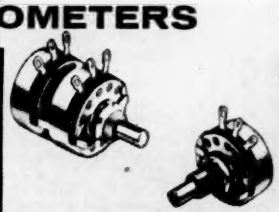
POTENTIOMETERS



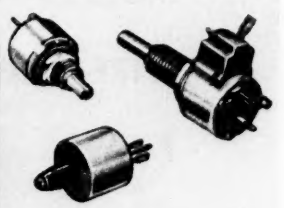
INDUSTRIAL—Type H with solid, hot molded resistor element. Quiet, improves with use. Life over 100,000 cycles. Rated 5 watts, 40°C; and 3 watts, 70°C.



STANDARD—Type J. Solid molded element. Quiet, reliable. Rated 2 watts, 70°C. Values to 5 meg.—less than 10% change in 100,000 cycles. Exceeds MIL-R-94B.



HIGH TEMPERATURE—Type K. Similar to Type J but rated 3 watts, 70°C; 2 watts, 100°C; and 1 watt, 125°C—derate to zero at 150°C. Many types and tapers.



MINIATURE—Type G. Solid molded element. Only 1/2" in diam. Plain or lock bushing; also with line switch. Rated 0.5 watt at 70°C. Values to 5 megohms.

FERRITES

TV CORES, including lightweight flared yokes; U, L, and O cores for color convergence; U and E flyback cores; and others. All have uniform magnetic properties.

FILTERS

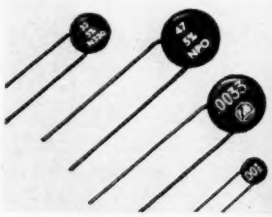
HIGH FREQUENCY low pass cascaded ceramic filters for elimination of radiation. Max ratings: 500 v DC at 125°C; RF current 0.25 amp; DC or LF current 5 amp.

POTENTIOMETERS

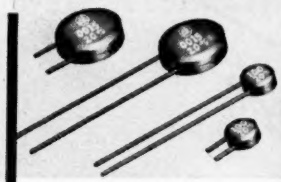
PRINTED CIRCUIT TYPE—Solid molded element. Rated 1/4 watt at 70°C. Type F is only 1/2" in diam. Screwdriver adjustment. Total resistance values to 5 meg.

THIN TYPE—Uses molded cover as actuator. Type T has solid molded element. Rated 1/2 watt at 70°C. Life in excess of 50,000 cycles. Total values to 5 megohms.

CAPACITORS

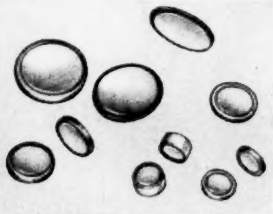


CERAMIC DIELECTRIC capacitors of superior quality, in a wide variety of types—GP (single and dual)—with no "rundown" on leads. Also, as TC and stable.



CERAMIC ENCASED capacitors for use where reliability and superior performance at high temp are important. Rated 500 v DC at 150°C. Tol: 5%, 10%, and 20%.

FEED-THRU & STAND-OFF discoidal capacitors for VHF and UHF range. No parallel resonance effects at 1,000 Mcps or less. Nominal values 4.7 to 1,000 mmf.



BARE DISC ceramic capacitors for direct mounting in printed circuit boards. Mechanically strong to avoid breakage in handling, installing, and soldering.

Allen-Bradley Co.
140 W. Greenfield, Ave.
Milwaukee 4, Wis.

In Canada:
Allen-Bradley Canada Ltd.
Galt, Ont.

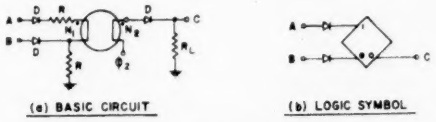
A-B QUALITY

ALLEN-BRADLEY
QUALITY
ELECTRONIC COMPONENTS

For more information circle **28** on inquiry card.

Pulse Magnetic Amplifiers

In the past, vacuum tubes and relays have been the basic components of logic circuitry. Being components of limited reliability, they have not always been satisfactory. The advent of transistors, magnetic cores, and silicon diodes has made possible the design of circuits having greatly improved reliability. The design to be described here will utilize magnetic cores and silicon diodes.



(a) BASIC CIRCUIT

(b) LOGIC SYMBOL

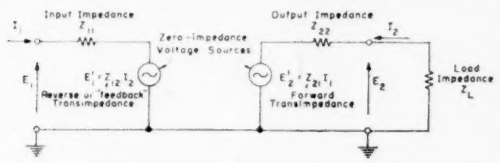
CORE-ARNOLD ENGINEERING 17-15 WRAPS 4-79 MO-PERMALLOY
N_1-34 TURNS #36
N_2-170 TURNS #36
*R-220 OHMS
D-051358A (HOFFMAN SPECIAL DIODE)

Practical considerations to enable the engineer to design a pulse magnetic amplifier to fit his needs will be presented. Two equations are given which relate switching time to ampere turns . . . . . With the equations and the characteristics of the magnetic material supplied by the manufacturer, a complete design can be accomplished. Each of the factors involved in pulse magnetic amplifier design will first be explained and then an actual pulse amplifier will be designed to illustrate the use of the design procedure . . . Simplification of logic circuit design is greatly facilitated by the use of a single basic logic module . . . (*From new "Hoffman Semiconductor Application Notes," Vol. 1, No. 5, Hoffman Electronics Corp., Semiconductor Div., 930 Pitner Ave., Evanston, Ill.*)

For this literature circle **205** on inquiry card.

Transfer-Function Meter

The performance of most electrical devices and circuits can be described by specifying a transfer function, which is the ratio of an output to an input quantity, or vice versa. The "alpha" and "beta" current ratios of transistors, the transconductance of

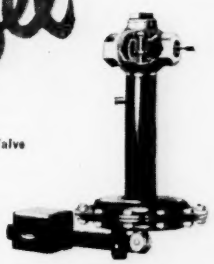


vacuum tubes, the gain of amplifiers, and the loss of attenuators and filters are common examples of widely used transfer functions. The new Type 1607-A Transfer-Function Meter can measure these and many other transfer functions over the frequency range from 25 Mc to about 1500 Mc. (*From General Radio Experimenter, Vol. 32 No. 10, General Radio Company, 275 Massachusetts Ave., Cambridge 39, Mass.*)

For this literature circle **206** on inquiry card.

If you need to reduce fluid pressure safely, economically... call for a valve from

Klipfel



No. 310 Reducing Valve

Klipfel makes Reducing Valves for every purpose—60 different types of them, in fact. They operate on air, gas, steam, water or other liquid, with initial pressures up to 300 psi and reduced pressures as low as vacuum. You can choose from five different inner valves, three different actuating means and four loading means.

Also available from Klipfel are Float Valves, Relief Valves and Temperature Regulator Valves—and special valves made of corrosion-resistant materials. For information on any valve, call your supply house or write for Catalog 54.

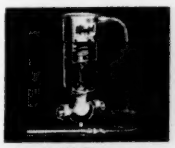
Call your supply house, or write for Catalog 54.

No. 410 Reducing Valve

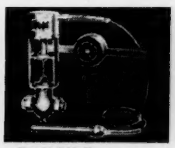
No. 300 Reducing Valve

AIR MAIL

Most items shipped within 24 hours after order is received

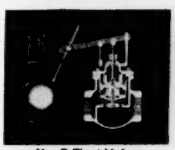


No. K-449 Temperature Regulator Valve



No. K-348 Temperature Regulator Valve

No. 135 Relief Valve



No. 7 Float Valve

No. 27 Float Valve

No. 135 Multiport Relief Valve

HAMILTON • OHIO Klipfel VALVES INC.

Automatic Temperature-and-Pressure-Regulating Valves Since 1902

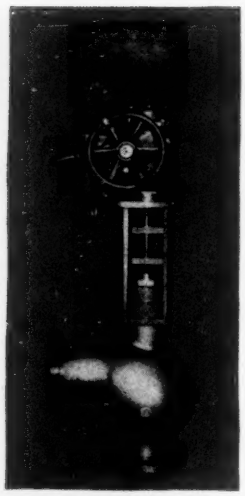
Float Valves • Temperature Regulators • Back Pressure Valves • Reducing Valves

A DIVISION OF THE HAMILTON-THOMAS CORPORATION

For more information circle **29** on inquiry card.

CONTROL VALVES BY CONOFLOW

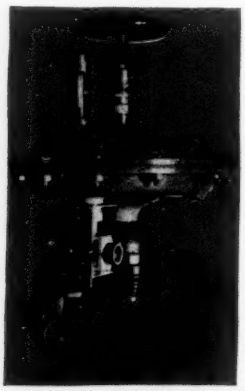
YEARS AHEAD IN DESIGN



SERIES S CONTROL VALVES

Specifically designed to handle the tough services which cause ordinary valves to fail.

- Sizes to 14"; pressure ratings to 2500 lbs.
- Extra heavy body construction exceeds ASA standards.
- Self-sealing bonnet will not leak regardless of temperature or pressure conditions.
- Patented Rotomotor actuator handles large sizes with high power requirements.



SERIES HB SAUNDERS VALVES

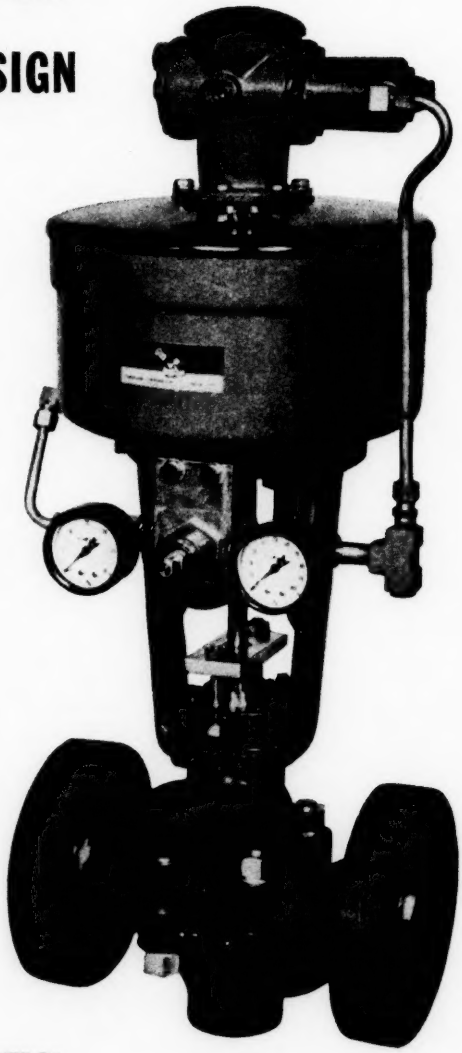
Original close-coupled design introduced by Conoflow has long been an industry standard.

- Completely engineered factory assemblies assure premium performance.
- Actuators for on-off or throttling control in all valve sizes.
- Exclusive Bonnet Loading System available for higher thrust outputs.
- Compact construction allows for more economical piping arrangements.

SERIES LB CONTROL VALVES

Quality construction and truly integrated body-actuator design completely outmodes conventional control valves.

- Cono J Positioner sets new industry standards for precise proportional positioning.
- Rugged cylinder actuator utilizes sturdy metal piston and exclusive lipseals which cannot leak.
- Single-seat body design guarantees positive, tight shut-off under any conditions.
- "Lift-out" seat ring can be replaced quickly with a minimum of effort.
- Extra thick body walls give added protection against corrosion and erosion.
- Simplified construction means less replacement parts and substantial inventory savings.



SERIES AB CONTROL VALVES

A line of economical control valves for handling small flows.

- Bodies available in two and three-way design, in all alloys.
- Extra long stroke; double that of conventional valves.
- Suitable for high pressures and corrosive services.
- Completely enclosed spring-over-diaphragm construction is compact and protects spring from atmospheric corrosion.

When you specify Conoflow control valves you get the best valve available for your control application. Write for literature or let us put you in touch with a Conoflow representative qualified to help solve your control problems. Conoflow Corporation, Dept. C-805, 2100 Arch Street, Philadelphia 3, Pa.

SEE US AT THE ISA SHOW—BOOTH 1246

Cono Controls®

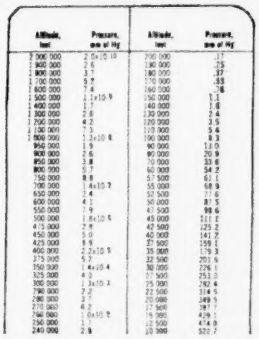
CONOFLOW CORPORATION

FOREMOST IN FINAL CONTROL ELEMENTS

Subsidiary of Walworth

For more information circle **30** on inquiry card.

Altitude Pressure Table

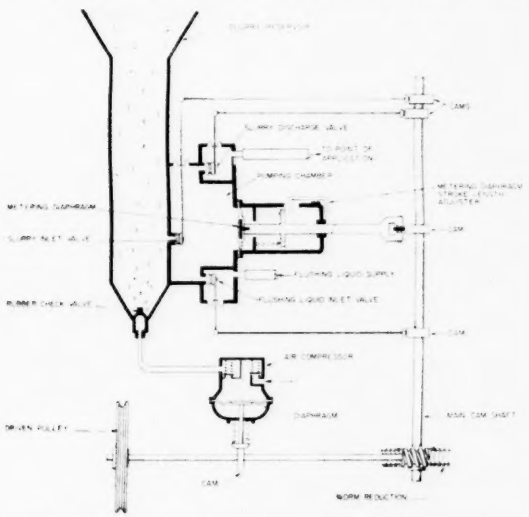


. . . (From handy wallet-size plastic table, F. J. Stokes Corp., 5500 Tabor Rd., Phila. 20, Pa.)

For this literature circle **207** on inquiry card.

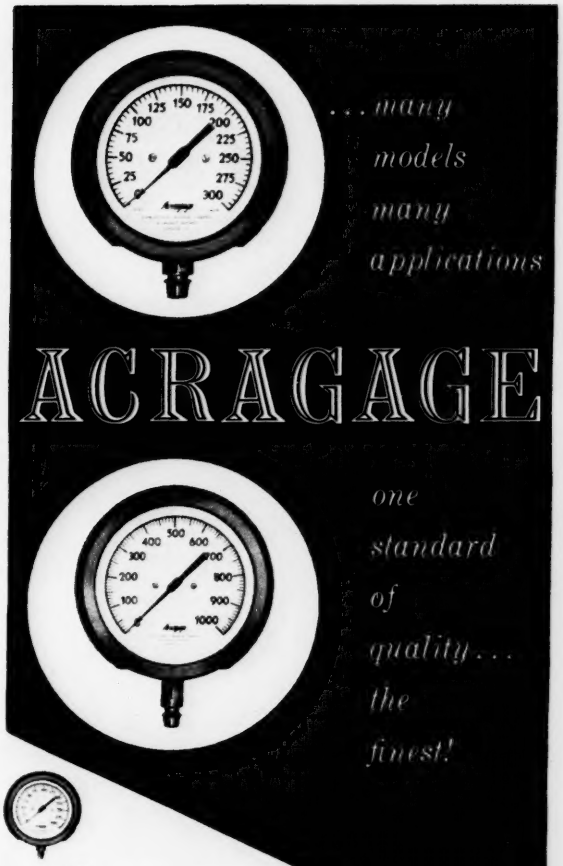
Slurry Feeder

The principle of operation (of the Series A-710 feeder) can best be understood by reference to the schematic diagram . . . The metering diaphragm and feeder valves are actuated by cams on the main cam shaft which is driven through a worm reduction gear. With the metering diaphragm in its extreme forward position, the flushing liquid inlet and slurry discharge valves are closed and the inlet valve from the slurry hopper is open. The backward or suction stroke



of the metering diaphragm draws a precise amount of concentrated slurry into the pumping chamber. At the end of the suction stroke, the slurry inlet valve is closed and the flushing liquid inlet and slurry discharge valves are opened. The diaphragm then moves forward . . . When the metering diaphragm again reaches its forward limit of travel, there is a short dwell period; the flushing liquid inlet and slurry discharge valves close and the slurry inlet valve from the hopper opens to allow slurry to be drawn from the hopper by the suction stroke of the diaphragm . . . *(From new 8-page Bulletin TP-10-M, Wallace & Tiernan Inc., 25 Main St., Belleville 9, N. J.)*

For this literature circle **208** on inquiry card.



The various industrial companies and government services using Acragages represent a cross section of modern technology, covering a wide range of products, services and research projects. While the applications may differ widely, a basic similarity lies in some of the major reasons why Acragages are preferred: high accuracy, precision manufacture, fast and easy calibration, built-in safety, and assured dependability.

Acragages are the most advanced of the bourdon tube type pressure gage. Besides high accuracy, they feature solid front cases providing complete safety as well as quick and easy access to the bourdon tube assembly and internal mechanism for easy calibration. This solid front case feature is standard with Acragage . . . only one of a number of advancements typifying Acragage's development policy.

ACRAGAGE GIVES YOU MORE GAGE PER DOLLAR

- VACUUM GAGES
- PRESSURE GAGES
- COMPOUND GAGES
- TEST GAGES
- ELECTRIC TRANSMITTER GAGES
- PNEUMATIC TRANSMITTER GAGES
- RECEIVER GAGES
- CHEMICAL PROTECTORS
- MILITARY OXYGEN FLOW INDICATORS
- MILITARY OXYGEN GAGES

INTERNATIONAL REGISTER COMPANY/INSTRUMENT DIVISION
Quality products since 1891
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INTERNATIONAL REGISTER COMPANY
INSTRUMENT DIVISION
2630 West Washington Blvd., Chicago 12, Ill.

Gentlemen: Please send me full information on Acragages and a copy of your latest catalog 981

Name_____
Title_____
Firm_____
Address_____
City_____ Zone_____ State_____

For more information circle **31** on inquiry card.

THE FIRST NEW CONCEPT IN DIGITAL DISPLAY SYSTEMS

Cubic
TRANSISTORIZED SYSTEMS

with built-in
rely/ance*

***Cubic's engineering philosophy regards reliability and ease of maintenance as inseparable features of a truly functional system.**

ONLY CUBIC DIGITAL DISPLAY SYSTEMS GIVE YOU:

LOW COST OF OPERATION — Proven reliability and practical maintenance features reduce costly down-time to a minimum.

VERSATILITY — All systems units standard size: each unit plugs into its own chassis; modifications for special equipment readily available; interchangeable units ideal for rack mounting.

RELIABILITY — Accuracy to .01%; resistor stability assured; complete transistorization eliminates warm-up time.

EASE OF MAINTENANCE — Stepping switches mounted on horizontal bars — swing up and out for easy access. Slide-out features allow quick replacement if system requirements change.

Compare Cubic Digital Systems . . . compare them for price, reliability and versatility. A fast prove-it-yourself demonstration will show you why Cubic Digital Systems will be your best instruments aid.

For complete information and/or demonstration call

BR 7-6780

5575 KEARNY VILLA RD.
SAN DIEGO 11, CALIFORNIA

Cubic CORPORATION

For more information circle **32** on inquiry card.

New—capillary tubing in 3000 ft. lengths for industrial instrumentation

Improved bore uniformity, broader size range, flow tested to your specifications

To meet the demands of modern instrument design and automated fabrication, Superior is now offering seamless capillary tubing in lengths up to 3000 ft. It is available in nine different materials from select-quality raw stock, including stainless steel, carbon steel, nickel and nickel alloy.

Scrupulous care in manufacture results in a finished product that is bright and scalefree, with an extremely smooth, uniform bore. The tubing is easy to weld, braze or solder. ODs range up to $\frac{3}{16}$ in.—IDs from .004 to .040 in. maximum.

When you order capillary tubing by Superior you are assured that your specifications will be met. In addition to 100% dimensional, pressure and finish inspections, we also can test lengths for flow rates with the latest equipment when specified. Rates can be varied from 5 to 3700 cc per min.

More information on Superior's improved capillary tubing products is yours for the asking. Send coupon today.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

All analyses .010 in. to $\frac{5}{8}$ in. OD—certain analyses in light walls up to $2\frac{1}{2}$ in. OD

West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif: RAymond 3-1331

SUPERIOR TUBE COMPANY
1968 Germantown Ave., Norristown, Pa.
Send me a copy of new Data Memorandum 11, on capillary tubing.

Name_____ Title_____

Company_____

Street_____

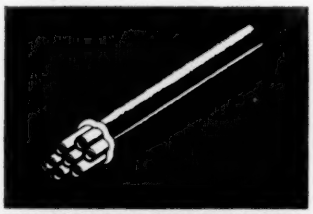
City_____ Zone____ State_____

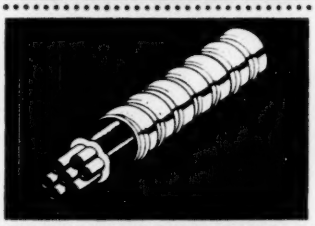
For more information circle **33** on inquiry card.

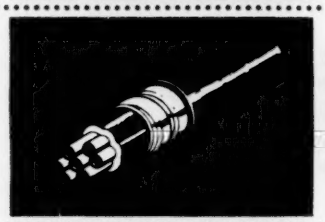
here's how to specify

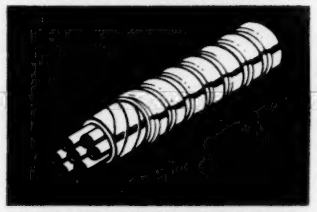
DEKORON INSTRUMENT HARNESS

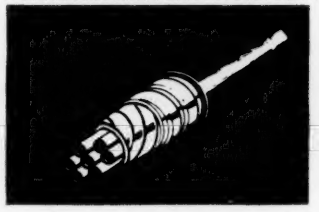
to fit your requirements exactly

ALUMINUM OR COPPER / POLYETHYLENE OR NYLON + plastic sheath =  FOR CORROSION RESISTANCE

DEKORON METL-COR / DEKORON POLY-COR + steel armor =  FOR IMPACT AND CORROSION RESISTANCE

ARMORED METL-COR / ARMORED POLY-COR + plastic sheath =  FOR IMPACT AND MAXIMUM CORROSION RESISTANCE

ALUMINUM OR COPPER / POLYETHYLENE OR NYLON + insulating tape + steel armor =  FOR IMPACT RESISTANCE IN DRY LOCATIONS

ARMORED TUBES + plastic sheath =  FOR CORROSION AND IMPACT RESISTANCE

No matter what your special environmental requirements for instrument tubing may be—no matter how stringent for corrosion, impact or fire resistance—there's a type of Dekoron instrument line harness to *satisfy them exactly*. In most cases you can get *delivery from stock*. And *all* Dekoron products have three things in common: Highest quality materials and construction . . . lowest possible installation cost . . . longest life of any instrument line harness. That's *Dekoron—America's Premier Instrument Tubing Line.*

AA-8384

Dekoron® products

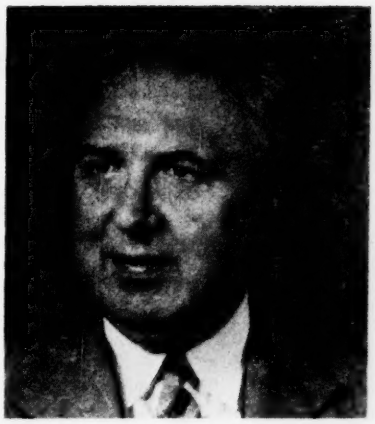
SAMUEL MOORE & COMPANY

DEKORON PRODUCTS DIVISION • MANTUA, OHIO

QUALITY • RESEARCH • SERVICE

For more information circle **34** on inquiry card.

BIOGRAPHIES of Significance



Prof. Carl F. Kayan is well known in the field of instrumentation and throughout the Instrument Society of America, which he helped to organize. Prof. Kayan has been teaching instrumentation in the Mechanical Engineering Department of Columbia University for 34 years, ever since he graduated from the same school. His biography is significant at a time when instrumentation is becoming recognized as an essential basis for technical education.

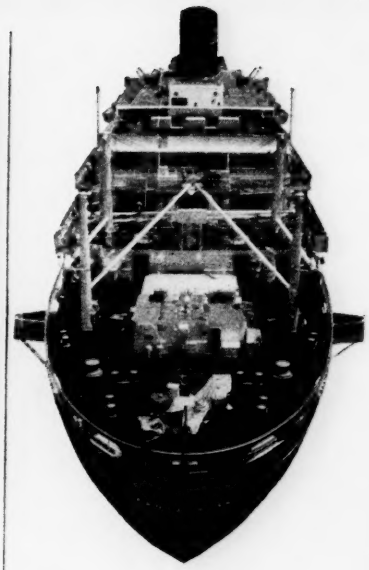
Professor Carl F. Kayan

Professor Carl Kayan was born in N. Y. in 1899. He has been on the Faculty of Mechanical Engineering at Columbia University for the past 34 years, staying faithful to his alma mater from which he received his A. B. (1922) and M.E. (1924) degrees. He started an instruments laboratory at Columbia in 1927 and simultaneously taught the first course on instrumentation—the first time this ever was done. He continued this course till 1955, when he went to Sweden. Specializing in thermodynamic applications and heat transfer, he is well known for his research in the development of electrical analog approaches, for the study of energy flow and energy-transport processes, and especially heat transfer, in which he has pioneered.

Prof. Kayan is a former president of the Instrument Society of America, which he helped to organize with Mr. Richard Rimbach and the late Maj. M. F. Behar. His affiliation of long standing with the American Society of Mechanical Engineers, the American Society of Refrigerating Engineers, and the American Society of Heating and Air Conditioning Engineers lead him to numerous international events conducted in Europe, at which he took part as speaker, lecturer or observer for the American Engineering societies. In particular, he has participated in meetings of the Institut Internationale du Froid, since 1951; in 1957 he was elected a vice-president of the Institut, is one of the delegates representing U.S.A. this September in Prague and Moscow, and is now chairman of the International Relations Committee of A. S. R. E. In 1955 he was visiting professor at the Royal Institute of Technology, Stockholm, and on numerous occasions has lectured in different countries abroad. He is at present quite active in the Engineers Joint Council; recently he was elected Fellow of the American Society of Heating and Air Conditioning Engineers. He is likewise a Fellow of A.S.R.E. and A.A.A.S. He is a member of the Air Pollution Board of the city of New York, chairman of the Program Committee of the AAAS for Section M (Engineering), and is now planning a program for a Conference on Unit Systems to be held in Washington, D. C., Dec. 29 and 30, 1958.

Prof. Kayan is the author of some 40 papers on electrical simulation of heat conduction and energy flow. He was honorary chairman of the Fourth International Automation Congress held in June 1958 in the Coliseum in New York where he was the chief speaker at the special opening luncheon, and introduced the representatives and officers of the various international and national groups which were represented at the Congress. He has been a reader of *INSTRUMENTS and AUTOMATION* for 30 years—since the magazine was first published in 1928.

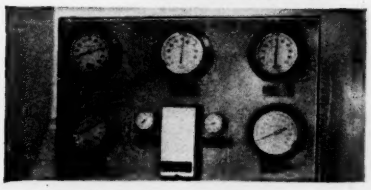
Prof. Kayan is married and has two children. Among his hobbies was mountain climbing, which he practiced in Switzerland on numerous vacations. He "made" 9 outstanding mountains, including Mont Blanc, Blumles Alp, and the Matterhorn. "Now I only look up to them," says Professor Kayan, with a dreamy expression in his eyes.



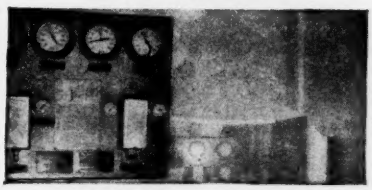
on the

Santa Rosa

Weksler Instruments



for temperature



pressure and humidity

Designed, engineered and manufactured for the finest . . . Weksler Instruments insure that any system is a better system!

Specify Weksler for your instrument requirements. Write for the Weksler catalogs . . . and use our advisory services without obligation

Photographs courtesy Newport News Shipbuilding and Dry Dock Company

WEKSLER INSTRUMENTS

WEKSLER INSTRUMENTS CORP.
FREEPORT, L. I., NEW YORK

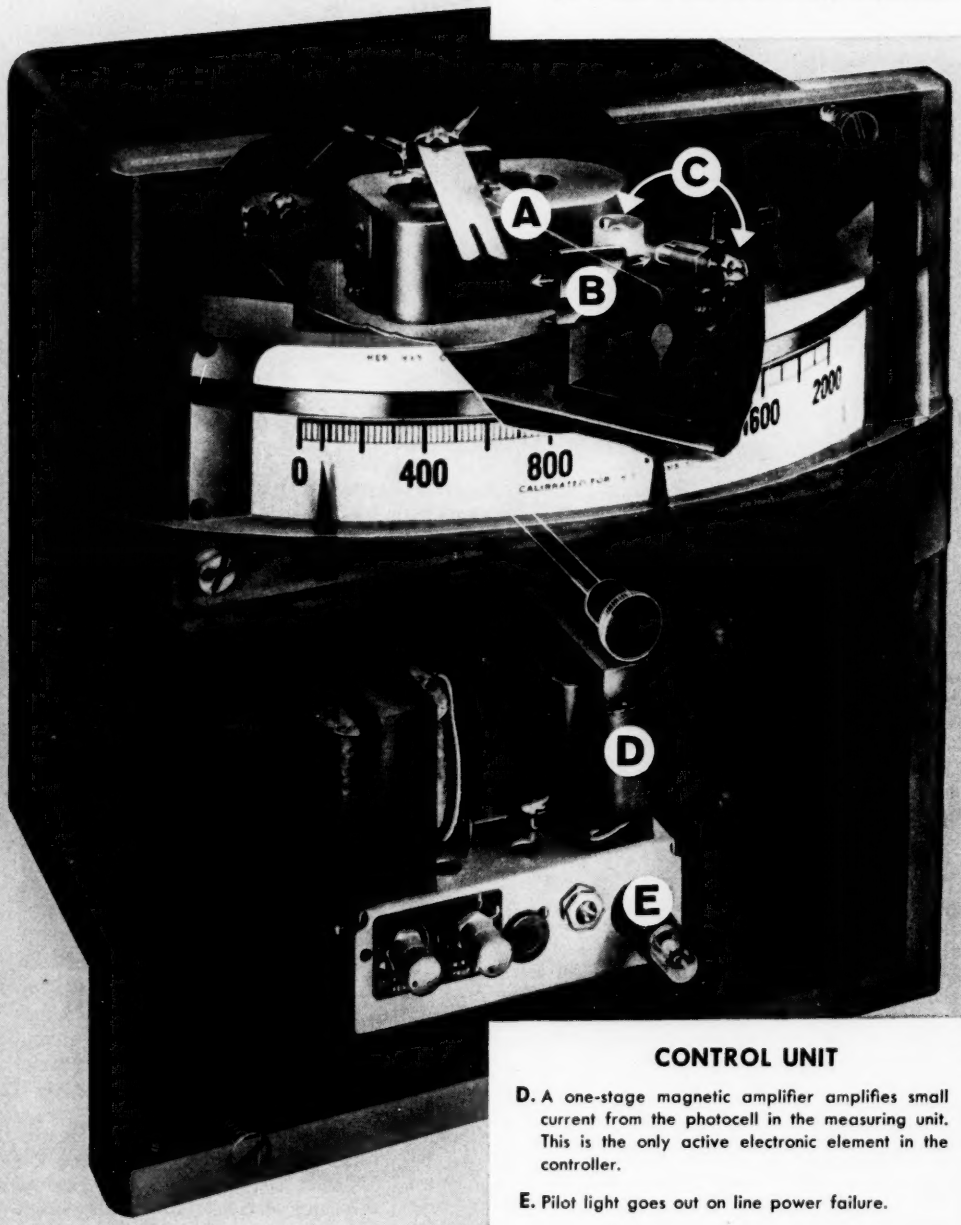
For more information circle **35** on inquiry card.

MEASURING UNIT

A. A thermocouple signal to a d'Arsonval galvanometer, the only moving part, moves the indicating pointer up scale.

B. Aluminum vane adjusts the amount of light received by the photocell from the operating lamp.

C. If operating lamp or photocell fails, output voltage assumes a value equal to high temperature.

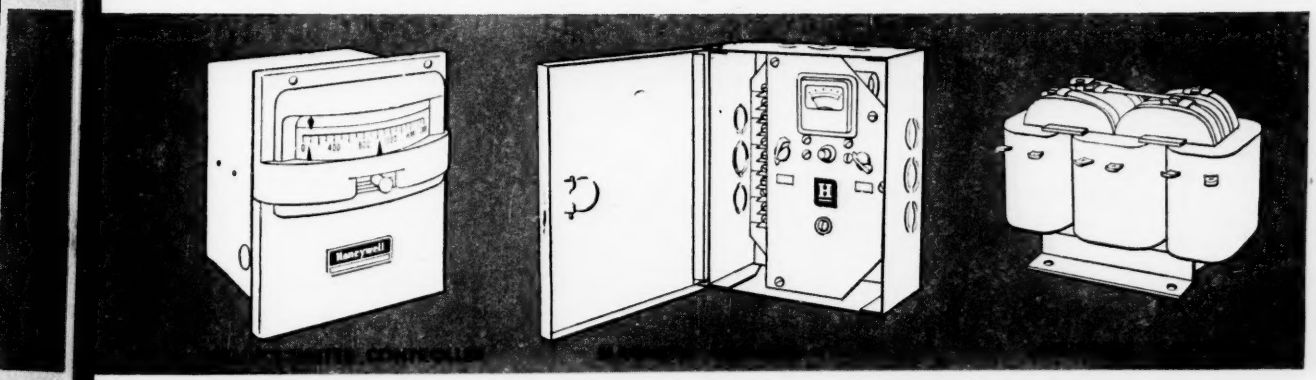


CONTROL UNIT

D. A one-stage magnetic amplifier amplifies small current from the photocell in the measuring unit. This is the only active electronic element in the controller.

E. Pilot light goes out on line power failure.

***Pyr-O-Volt* controller is dependable and trouble-free. Built-in voltage regulator maintains voltage within ±1% of level required for maximum operating stability. Thermocouple burnout protection is optional. Spare operating lamp is supplied with all instruments. Available in both horizontal and vertical case models.**



For your electric heating applications...

Use this accurate, dependable *Pyr-O-Volt** controller

- **No tubes to wear out**
- **Voltage regulation**
- **Fail-safe design**
- **Contactless, stepless control**

Here's an accurate instrument for reliable stepless control of saturable reactors, r.f. generators and other power amplifiers. It has a proportional band adjustable from ⅔% to 5%, and a manual reset adjustment which shifts the control point over 100% of the proportional band.

The *Pyr-O-Volt* controller can control saturable core reactors up to 100 kva, if used with a Brown magnetic amplifier. You can also use this proportional output millivoltmeter-controller with the General Electric *Reactrol***, and with the Westinghouse *Furnatron*.*** Complete packaged systems available.

Contact your nearby Honeywell field engineer for complete details. He's as near as your phone.

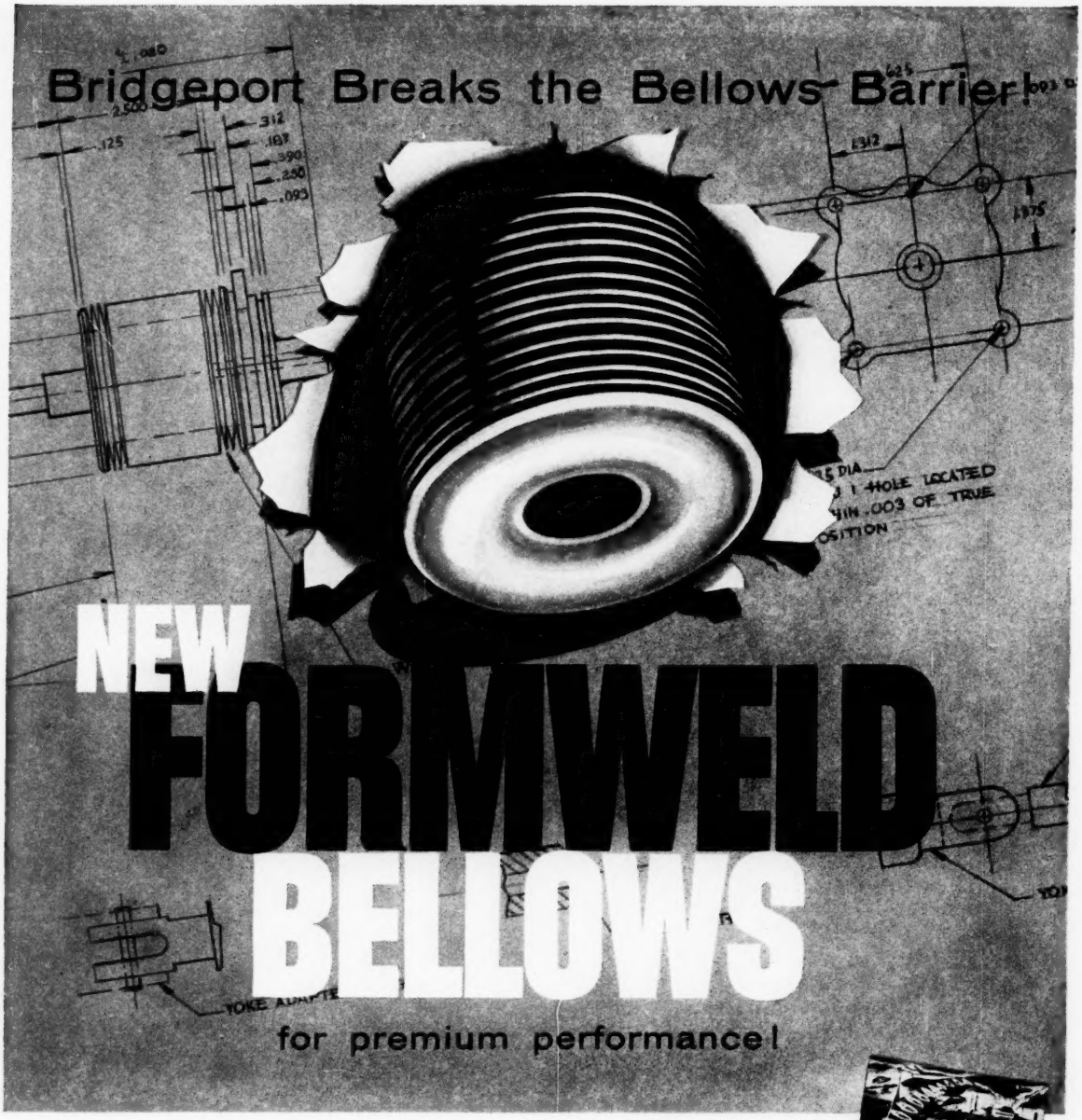
MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

H HONEYWELL *First in Control*

● **REFERENCE DATA: Specification S103-5**

*Tradename, Minneapolis-Honeywell Regulator Co.
**Tradename, General Electric Co.
***Tradename, Westinghouse Electric Corp.

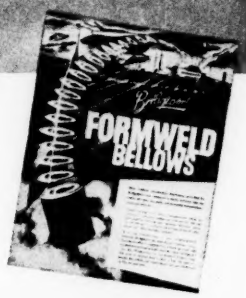


Now . . . you can confidently specify metallic bellows for even the toughest combination of environmental and service conditions . . . and get the most accurate and reliable bellows ever built!

Now . . . service limits are greatly increased by a wider choice of bellows metals, including Inconel-X, titanium, zirconium, Hastelloys, Monels, Ni-Span-C, 17-7 PH and 300 and 400 stainless steels, beryllium copper, super corrosion resisting and other weldable alloys.

Precision welding results in exacting control of dimensional tolerances on free length, I.D., O.D., parallelism of plates and end fittings, and concentricity of end fittings. Improved properties in FORMWELD Bellows include greater temperature, corrosion and fatigue resistance, ability to withstand higher loads without deformation, lower hysteresis with greater linearity, and complete uniformity of properties. More free plates per inch assure space savings. Available in sizes from ¼" to 18" plus O.D.

WRITE FOR BULLETIN G-709



Mr. Controls®

Robertshaw-Fulton
CONTROLS COMPANY

BRIDGEPORT THERMOSTAT DIVISION
Milford, Connecticut

For more information circle **36** on inquiry card.

READ-OUT DOWN TO

.002 V. dc

DU MONT 405

THE DUAL INPUT

Like having **two** VTVM's connected into a circuit for comparison readings — the 405 permits instantaneous switching between two inputs — either ac or dc — without disturbing a single probe in the circuit. The same switch provides a Meter Zero position for convenient, fast calibration; again, without disturbing test probes.

And that's not all! The 405 offers full-scale sensitivity of 100 millivolts, dc or ac, resulting in accurate read-outs down to .002 volts dc, or .01 volts ac.

Add these outstanding features to the following, and you'll quickly discover why the 405 is **today's best buy in a VTVM . . .**

- Full scale ranges of .1, .3, 1, 3, 10, 30, 100, 300 and 1000 volts dc. Accuracy ±2% full scale. Full scale ranges of .1, .3, 1, 3, 10, 30, 100* and 300* volts ac. Accuracy ±3% full scale.
- Measurements from dc to 700 mc.
- Ohmmeter, 7 ranges, calibrated 500 ohms-500 megohms. Maximum short-circuit current 8.5 ma.
- Completely isolated ground circuit permits safe off-ground measurements up to 1000 volts dc.
- Very low drift. Less than ±5 millivolts maximum on any scale.
- Regulated dc and filament supply.
- Amplifier output available for accessories.
- Illuminated, mirror-backed, 4" scale.
- Compact. Weighs only 12 lbs.
- Built-in probe storage compartment.

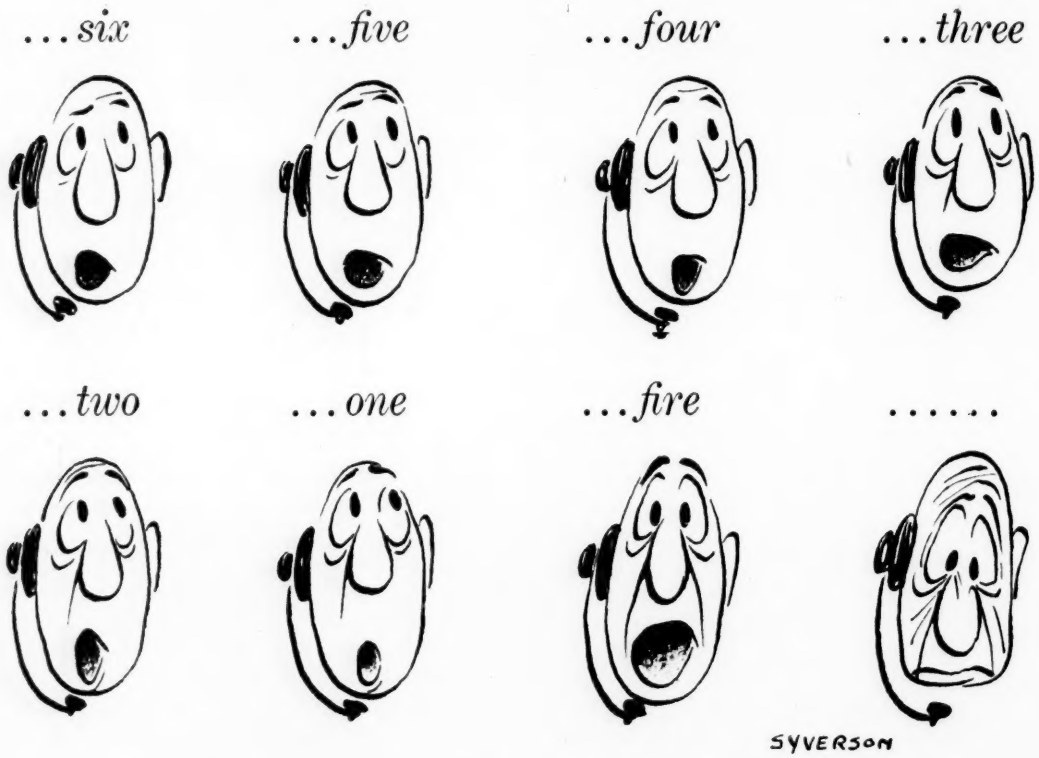
*With Cat. No. 4050 Attenuator probe.

PRICE $265
INCLUDING UHF, VHF AND DC PROBES

$305.00
With UHF, VHF, Attenuator and dc probes
Prices F.O.B., Clifton, N. J., U.S.A.

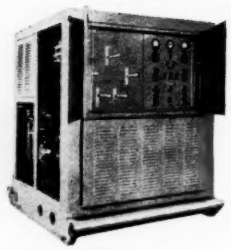
Write For Complete Information...

DU MONT® INSTRUMENT DIVISION
ALLEN B. DU MONT LABORATORIES, INC., CLIFTON, N. J., U.S.A.
For more information circle **37** on inquiry card.



When the target is space and a million dollars' worth of missile rests idly on the ground—not even a long countdown helps. In a showdown situation, the successful shoot depends on the "go, no-go" type of test that pinpoints the trouble.

NEXT TIME...LOOK TO INET FOR PRECISE GROUND POWER



This INET 400-cycle ground power unit was tailor-made for the Atlas. In meeting all of Convair's specifications for pre-flight calibration of electrical systems, the unit operates in parallel with the missile's power system and provides remote control regulation. Frequency regulation is ±0.2%. With shock load equal to a third of rated output, frequency recovers to ±0.2% in 0.15 seconds. Voltage regulation is ±0.5% with recovery time at 0.30 seconds.

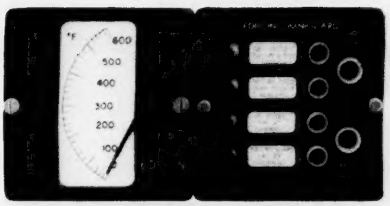
Missile men desiring a special reprint of the above cartoon should write to "Count-down", c/o Inet Division of Leach.

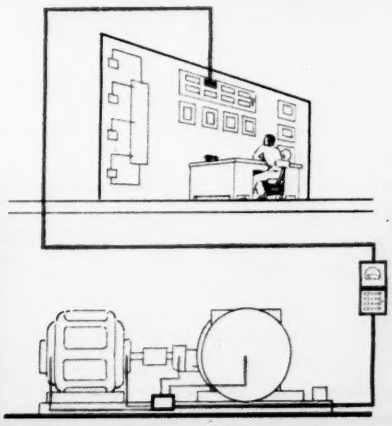
INET DIVISION LEACH CORPORATION

18435 SUSANA ROAD, COMPTON, CALIFORNIA

DISTRICT OFFICES AND REPRESENTATIVES IN PRINCIPAL CITIES OF U. S. AND CANADA

For more information circle **38** on inquiry card.

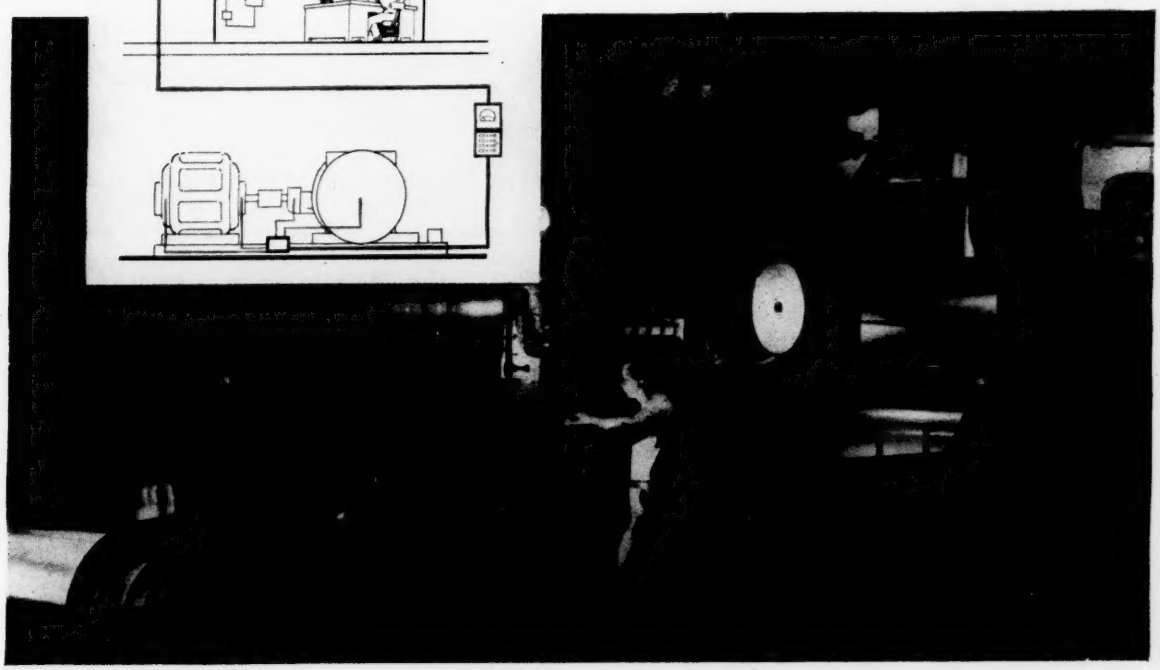




THOMAS A.

EDISON

omniguard system provides low cost temperature monitoring



Edison Omniguard is the simplest and most flexible monitoring system devised for protection against excessive bearing temperatures, gases and liquids. In an Omniguard installation, plug-in monitor units are grouped according to individual requirements—can be added, removed or switched to other equipment without disturbing the system. Individual alarm settings on each point can be changed at any time without special tools.

This kind of flexibility pays off in reducing installation costs by 50% or more . . . permits purchase of minimum number of units needed at any one time . . . and the addition of more points as new equipment is installed.

Other exclusive Omniguard advantages: Single indicator serves multiple points • each circuit is 'on guard' at all times • no moving parts, nothing to wear out • alarm positively identifies trouble point.

Edison Resistance Temperature Detectors coupled with automatic monitors are low cost insurance against loss of production time, equipment replacement and costly repair charges.

Typical Omniguard Panel shows group of monitor units with their alarm lights, test buttons, and temperature read-out switches. Additional units can be installed in a variety of ways to suit your individual needs.

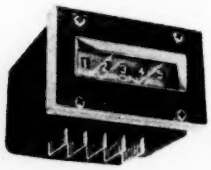
For additional information on the Edison Omniguard, write for Bulletin 3036B.

Thomas A. Edison Industries

INSTRUMENT DIVISION

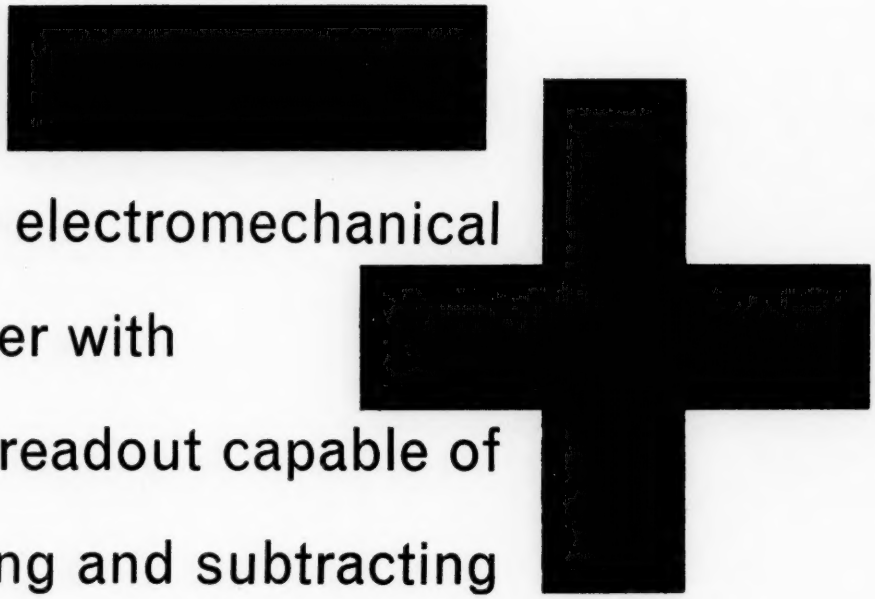
24 LAKESIDE AVENUE, WEST ORANGE, N. J.

For more information circle **39** on inquiry card.



COMPARE FEATURES AND YOU WILL SPECIFY NEURON!

Neuron High-Speed Electromechanical Counter, now manufactured by the Data Instruments Division of Telecomputing Corporation, is the same highly reliable Neuron counter which has enjoyed wide acceptance in a great variety of totalizing applications. ▪ Prompt Delivery – assured by Telecomputing's resources and facilities. ▪ High Speed – counting rate to 40 per second. ▪ Precision – cannot double index. Full count registered on leading edge of input pulse. ▪ Add and Subtract – accepts random add and subtract pulses. ▪ Instant Reset – mechanical or electrical. ▪ Environmental Capabilities – balanced moving elements provide exceptional resistance to vibration and shock. ▪ Switch and visual readout. ▪ Designed for panel mounting. ▪ Specify Neuron for the solution of tabulating problems that ordinary counters cannot solve. For complete information, write, wire, phone, DATA INSTRUMENTS DIV. ▪ TELECOMPUTING CORP., 12838 Saticoy St., N. Hollywood, Cal.



For more information circle **40** on inquiry card.

events

October 8-10

IRE Canadian Convention, sponsored by Canadian Sections of IRE, Exhibition Park, Toronto, Canada. For information write Raymond J. A. Turner, 1819 Yonge St., Toronto 7, Canada.

Oct. 13-15

1958 National Electronics Conference —the 14th Annual Forum on Electronic Research, Development and Application sponsored by the American Institute of Electrical Engineers, Illinois Institute of Technology, Institute of Radio Engineers, and Northwestern and Illinois Universities, Hotel Sherman, Chicago. For information write National Electronics Conference publicity chairman, c/o Illinois Bell Telephone Co., 208 W. Washington St., Chicago 6, Ill.

October 13-15

1958 International Systems Meeting, Hotel Penn-Sheraton, Pittsburgh, Penna. For information write A. M. Motter, Jones & Laughlin Steel Corp., #3 Gateway Center, Pittsburgh 30, Penna.

Oct. 14-16

Annual Exposition Competition and Short Course sponsored by the Society of Industrial Packaging and Materials Handling Engineers, Chicago Coliseum, Chicago. For information write G. Cornwall Spencer, 327 S. LaSalle St., Chicago 4, Ill.

Oct. 22-24

Fifth National Vacuum Symposium of the American Vacuum Society, Sir Francis Drake Hotel, San Francisco, Calif. For information write Wilfrid G. Matheson, 60 Boston St., Salem, Mass.

October 22-26

Third Conference and Exhibit of Instrumentation and Automation, Palazo dell'Arte al Parco (Triennale), Milan, Italy. For further information contact Strumentazione e Automazione, Via Marcona 15, Milan, Italy.

October 26-28

SAMA Laboratory Apparatus and Optical Sections' Midyear Meeting, Westchester Country Club, Rye, N.Y. For information write Jim Irving, SAMA, 20 N. Wacker Dr., Chicago 6, Ill.

October 27-28

Radio Fall Meeting of the Electronic Industries Association, Sheraton Hotel, Rochester, N. Y. For information contact the EIA office, 11 West 42nd St., N. Y. 36, N. Y.

OVERHEATING DAMAGE

melts processing profits!

FULTON SYLPHON

SAFETY TYPE

TEMPERATURE REGULATOR

Don't risk costly damage to products in process . . . or injury to personnel. Install a SAFETY TYPE Fulton Sylphon No.1006 Series Temperature Regulator. Control valve automatically *closes* to prevent overheating if thermostatic charge is lost due to accidental damage to the unit. Self powered. Large two-ply seamless Sylphon® Bellows assures sensitivity and extra power over an extended life. Teflon chevron valve stem packing prevents sticking . . . assures smoother control . . . requires no lubrication. Sizes from ¼" through 4". Whatever your process, check up on this safety "insurance" now. Write for Bulletin D-RL.

Mr. Controls®

Robertshaw-Fulton CONTROLS COMPANY

FULTON SYLPHON DIVISION • Knoxville 1, Tenn.

For more information circle **41** on inquiry card.

New polyvinyl T/c extension wire resists moisture and combustion

. . . available through your HSM (Honeywell Supplies Man)

HERE'S a thermocouple extension wire with superior insulation. Each of the two solid conductors is insulated with .015″ polyvinyl, and the pair is further protected by an outer .02″ polyvinyl jacket. It's the ideal wire for even the toughest service. What makes it better than ever is a *new kind* of polyvinyl insulation that adds extra serviceability.

Ask your local HSM (Honeywell Supplies Man) to tell you about this new wire . . . and to discuss how the HSM Plan can bring new convenience and economy to all your pyrometer supplies purchases. Call him today, at your local Honeywell office . . . as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Check these features:

WON'T BECOME TACKY or stick to conduit walls, even when overheated.

WON'T SUPPORT FLAME. Fire merely chars the coating. You can rewire without replacing the conduit.

ABRASION-RESISTANT. Jacket won't break or fray in roughest service.

EASY TO PULL THROUGH CONDUIT because jacket is smooth.

WEATHER-PROOF . . . double vinyl insulation gives extra protection.

MOISTURE-RESISTANT. *Completely* moisture-resistant.

FLEXIBLE. Can be flexed safely . . . will not crack or split.

● **REFERENCE DATA: Write for Specification S002-1, and for Pyrometer Supplies Buyers' Guide No. 100-6.**

Honeywell

First in Control

EVENTS—CONTINUED

October 27-29

East Coast Aeronautical and Naval Electronics Conference, Lord Baltimore Hotel & 7th Reg. Armory, Baltimore, Md. For information write R. L. Pigeon, Westinghouse Fleet Corp., Air Arm. Div., P.O. Box 746, Baltimore, Md.

October 29-30

Fifth Annual Computer Applications Symposium sponsored by Armour Research Foundation, Morrison Hotel, Chicago, Ill. For information write F. C. Bock, Armour Research Foundation of Illinois Institute of Technology, Technology Center, 10 West 35th St., Chicago 16, Ill.

October 30-31

Fourth Electronic Business Systems Conference sponsored by the Western Division, National Machine Accountants Assoc., Olympic Hotel, Seattle, Wash. For information write Jack Armstrong, P. O. Box 134, Seattle 11, Wash.

October 30-31

1958 Electron Devices Meeting, Mechanics Bldg., Boston, Mass. For information write C. J. Lahanas, General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

November 3-7

The American University's Fifth Institute on Electronics in Management, Washington, D. C. For information write Ruth Barker, The American University, Massachusetts & Nebraska Aves. N. W., Washington 16, D.C.

November 5-7

Society for Applied Spectroscopy Annual Meeting and Instrument Exposition and Joint Meeting with ASTM Committee E-13 On Absorption Spectroscopy, Hotel New Yorker, New York City, N. Y. For information write Paul Lublin, Sylvania Electric Products Inc., Bayside, L.I., N. Y.

November 6-7

Seventh Annual Instrumentation Conference, on campus of Louisiana Polytechnic Institute. For information write Stewart Baggarly, Louisiana Polytechnic Institute, Dept. of Mech. Engineering, Ruston, Louisiana.

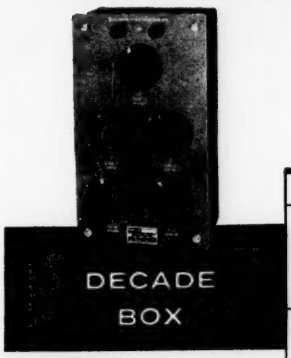
November 6-7

Professional Group on Nuclear Science, Institute of Radio Engineers, Villa Hotel, San Mateo, Calif. For information write Mr. H. Malcolm Ogle, Mgr. General Electric's Atomic Power Equipment Dept., San Jose, Calif.

November 17-20

Conference on Magnetism and Magnetic Materials Sheraton Hotel, Phila., Pa. For information write John Leslie Whitlock Assoc., 6044 9th St., N., Arlington 5, Va.

DECADE RESISTANCES



. . . with precision wirewound resistors mounted on steatite-insulated switches. *TEN* resistors per decade . . . giving better than 0.1% accuracy above 10 ohms.

Type	Dials	Ohm Steps	Total Resistance—Ohms	Price
817	3	0.01	11.1	$60.00
818	3	0.1	111	62.00
820	3	1	1,110	69.00
821	3	10	11,100	70.00
822	3	100	111,000	68.00
823	3	1,000	1,110,000	77.00
824	3	10,000	11,100,000	120.00
817-A	4	0.01	111.1	75.00
819	4	0.1	1,111	81.00
825	4	1	11,110	88.00
826	4	10	111,100	87.00
827	4	100	1,111,000	92.00
828	4	1,000	11,110,000	139.00
8285	5	0.1	11,111	100.00
829	5	1	111,110	105.00
830	5	10	1,111,100	113.00
831	5	100	11,111,000	155.00
817-C	6	0.01	11,111.1	112.00
8315	6	0.1	111,111	117.00
832	6	1	1,111,110	126.00
833	6	10	11,111,100	169.00

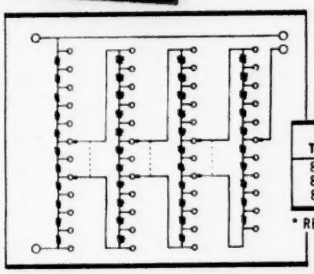
Type*	Dials	Ohm Steps	Total Resistance—Ohms	Price
435	1	0.1	1	$12.00
436	1	1	10	13.25
437	1	10	100	13.25
438	1	100	1,000	15.00
439	1	1,000	10,000	16.00
440	1	10,000	100,000	18.50
441	1	100,000	1,000,000	32.50
442	1	1,000,000	10,000,000	60.00

* Knob (#M-25594) not included. Available at additional cost.

Shallcross

DECADE VOLTAGE DIVIDERS

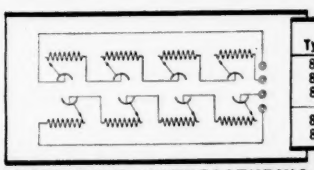
. . . same quality construction as in Decade Resistances. Choice of Kelvin-Varley or conventional potentiometer circuits.



KELVIN-VARLEY CIRCUIT

Type	Dials *	Input Resistance (Accuracy ±0.05%)	Price
8350	4	10,000	$140.00
8349	4	50,000	145.00
8348	4	100,000	150.00

* RESOLUTION—Any ratio between 0.0000 and 1.0000 in steps of 0.0001.



POTENTIOMETER CIRCUIT

Type	Dials	Ohm Steps	Total Resistance (Accuracy ±0.1%)	Price
837	4	0.1	1,000	$126.00
835	4	1.0	10,000	139.00
836	4	10.0	100,000	146.00
849	5	0.1	10,000	165.00
848	5	1.0	100,000	176.00

SHALLCROSS MANUFACTURING COMPANY, SELMA, N. C.

See us at the ISA Show, Booths 1417-1419

New Address

For more information circle **42** on inquiry card.

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters
INLET PORT
DISCHARGE PORT
DISCHARGE PORT
INLET PORT

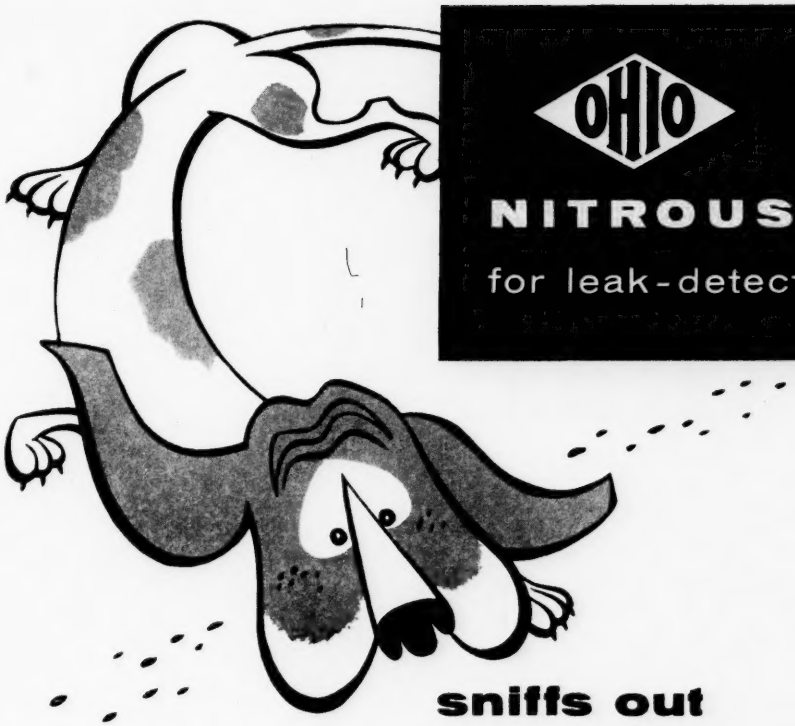
Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.



OHIO NITROUS OXIDE

for leak-detection devices

sniffs out microscopic leaks!

OHIO NITROUS OXIDE

- Odorless and Inert
- Nontoxic
- Noncorrosive
- Nonflammable
- Economical
- Will not contaminate test pieces

FREE TECHNICAL AID is available in the use of nitrous oxide for leak detection on pressure vessels, piping systems, auto suspension systems, or in any other problem concerning leak detection. For further written information, please write Dept. IA-1 requesting the following bulletins:

1A Chemical, Physical and Pharmacological Properties of Nitrous Oxide with Results of Corrosion Tests.

1B Gas Service Equipment for Nitrous Oxide Supply.

Infrared determination of nitrous oxide gives you a highly sensitive, clean and flexible method of leak detection when used for test pieces of many sizes, and for large and small quantities. Just a few parts of nitrous oxide can be detected in a million parts of air.

Audible or visual warning devices may be used. This method is insensitive to usual atmosphere components, such as moisture, carbon dioxide and hydrocarbons.

Nitrous oxide offers you top efficiency, and does so at an exceptionally low cost when compared to other gaseous agents.

Ohio, the world's largest producer, assures you of nationwide availability of nitrous oxide through its 32 branch offices and over 70 warehouse points.

"Service is Ohio Chemical's Most Important Commodity!"

Ohio Chemical

OHIO CHEMICAL & SURGICAL EQUIPMENT CO.
Madison 10, Wisconsin
(A Division of Air Reduction Company, Incorporated) AIRCO

Dept. IA-9
Please send me Bulletins 1A and 1B, described above.

Firm Name.....

Address.....

City..... Zone..... State.....

Your Name..... Title.....

At the frontiers of progress you'll find **An Air Reduction Product**... **Ohio**: Medical Gases and hospital equipment • **Airco**: Industrial gases, welding and cutting equipment, and acetylenic chemicals • **Pureco**: Carbon dioxide, liquid solid ("Dry Ice") • **National Carbide**: Pipeline acetylene and calcium carbide • **Colton Chemical**: Polyvinyl acetates, alcohols and other resins

For more information circle **43** on inquiry card.

Foxboro introduces

ELECTRONIC CONSOTROL* INSTRUMENTATION

On September 15th, at the I.S.A. Show in Philadelphia, The Foxboro Company will unveil Electronic Consotrol Instrumentation...counterpart of its world-famous pneumatic Consotrol line. ✓ ✓ ✓ Including a complete range of transmitters, indicators, recorders, controllers and valve operators, Electronic Consotrol Instrumentation covers every function in the control loop...provides advanced-design electronic control systems for all modern requirements. ✓ ✓ ✓ In these systems, process measurements such as temperature, pressure, flow and level, are converted to a proportional current signal at the transmitter. Long-distance transmission is instantaneous...over unshielded lines...to small-case, Consotrol panel-type receivers at the central control station. ✓ ✓ ✓ The full story on this major Foxboro contribution to better process control will be presented in Booth No. 12-72 at the I.S.A. Show. Or, write for comprehensive Bulletin 21-10. The Foxboro Company, 469 Norfolk Street, Foxboro, Mass.

*Reg. U.S. Pat. Off.

FOXBORO

REG. U.S. PAT. OFF.

Foxboro makes a better instrument...
or Foxboro doesn't make it

For more information circle **44** on inquiry card.

BOOK Reviews

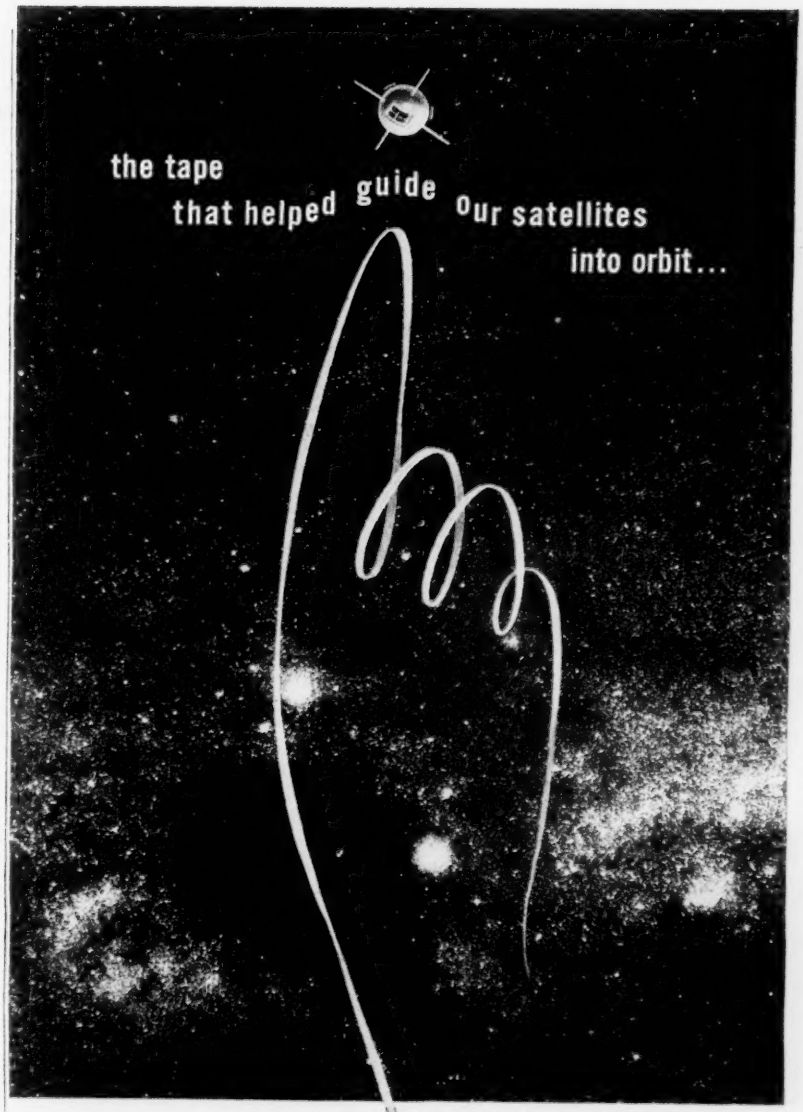
Techniques of Magnetic Recording, by Joel Tall [c1958.] Macmillan Co., New York 11, N. Y. 472p. $7.95. 8½ in. Clear, non-mathematical treatment. Briefly outlines development since the first U. S. patent (to Poulsen) in 1899. In addition to fundamental theory, techniques, and maintenance, gives attention to recording in special fields. More than 30 pages are devoted to "recording sound in nature" by Dr. P. P. Kellogg.

Digital Techniques for Computation and Control, by Martin L. Klein, Harry C. Morgan and Milton H. Aronson. [c1958.] Instruments Publishing Co., Pittsburgh 12, Pa. 392p. $6.00. Offered as the first exhaustive treatment of the subject, with much material not previously published. Prepared as a course for practicing professional engineers and technicians.

Lectures on Strain Gage Techniques, by William M. Murray and Peter K. Stein. 2v. c1957. Univ. of California at Los Angeles and Society for Experimental Stress Analysis. 657p. unbound. 10⅞ in. Presented at Univ. of California at Los Angeles, Aug. 19-23, 1957. Reproduced from typewritten copy.

Handbook of Electronic Measurements [Ed. 2.], v. 1, edited by Moe Wind. [1957.] Interscience Publishers, New York 1, N. Y. various paging. $15 for 2v. 11¼ in. Presents fundamental principles, and deals with equipment and procedures for measurement of voltage and current, power, impedance and circuit elements, and frequency and wave length.

Engineering Systems Analysis, Robert L. Sutherland, 224 pages, cloth, Addison-Wesley Publishing Co., Reading, Mass., 1958, $7.50. Written for students of engineering at the undergraduate level, this book covers the response of elementary systems (mass-spring-damping, L-R-C, etc.) in thorough manner, and then introduces the subjects of feedback control and analog and digital machines.



SOUNDCRAFT TYPE A TAPE FOR DIGITAL RECORDING

The Ford Instrument guidance system in Army Jupiter-C missiles that launched the Explorers into space...and the recording system in the Navy's Vanguard...employed a most reliable magnetic medium — Soundcraft Type A Tape. Only Soundcraft Type A Tape has electrical and physical stability to merit selection in these vital missions ...and in your own instrumentation applications. The RCCH oxide formulation in Type A Tape provides higher signal output and greater retentivity ... plus unique surface hardness and high thermal stability. Soundcraft's exclusive Micro-polishing and Uni-level coating processes help provide the electrical and physical uniformity found only in Soundcraft Type A Tape. Send for detailed Type A Brochure!

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For more information circle **45** on inquiry card.

CRESCENT
POLYETHYLENE
INSTRUMENT TUBING

Costs Less—Is Easier To Install

SIX DIFFERENT TYPES TO MEET YOUR SPECIFIC NEED

CRESCENT POLYETHYLENE MULTITUBE is 2 to 37 precision Polyethylene tubes *spirally cabled* together for greatest flexibility. The tubing assembly is protected against mechanical injury by an interlocked galvinized steel armor, Polyvinyl Chloride sheath, or other sheaths, as below.

CRESCENT POLYETHYLENE PRECISION INSTRUMENT TUBING

TYPE P is manufactured from the best high molecular weight virgin Polyethylene compound and TYPE XP of high modulus virgin Polyethylene compound selected for their superior resistance to environmental stress cracking and aging. Extensive research, improved manufacturing methods and rigid test standards have developed CRESCENT Polyethylene tubing to its present level of highest quality. It is furnished as single tubing in ¼", ⅜" and ½" sizes in up to eight bright colors. It is used exclusively in manufacturing CRESCENT POLYETHYLENE MULTITUBE in types as follows:

STANDARD TYPES

TYPE PA—Interlocked metallic armor provides complete mechanical protection.

TYPE PAT—Polyvinyl chloride sheath over the armor adds corrosion protection for the armor. Can be buried in the earth.

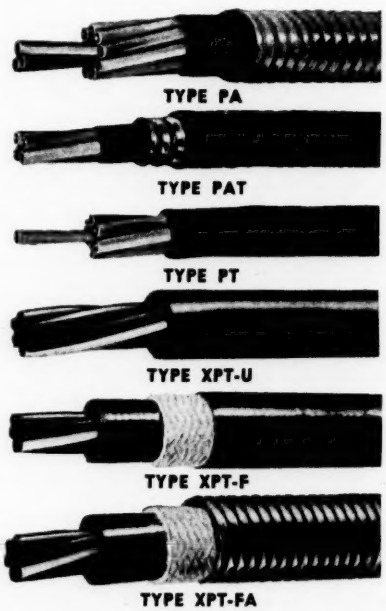
TYPE PT—PVC sheath gives limited mechanical protection. For use in troughs, trays or conduit.

SPECIAL SERVICE TYPES

TYPE XPT-U—Extra heavy PVC sheath over high modulus TYPE XP tubing permits direct burial, or use above ground where subject to moderate abuse.

TYPE XPT-F—Same as XPT-U with heavy asbestos braid and outer PVC sheath. Provides time delay in event of flash fire.

TYPE XPT-FA—Same as XPT-U with heavy asbestos braid and interlocked metallic armor. Provides complete mechanical protection, as well as time delay in event of flash fire.



Write for complete information on these types, as well as types employing copper or aluminum tubing. Ask for new bulletin No. 458.

Visit us at Booth #1155 at I.S.A. Show, Philadelphia, Sept. 15-19, to discuss this answer to low cost pneumatic instrument tubing problems.

CRESCENT INSULATED WIRE & CABLE CO.

TRENTON, N. J.

For more information circle **46** on inquiry card.

New program timer features complete adjustability

In many applications, a timer has a "standard" job to do throughout its expected life, never requiring a change of timing sequence. But in many others, it's desirable to be able to change the timing sequence and the intervals making up the sequence in a complete cycle.

The new Cramer Type 511 and Type 521 Cycling Timers fill the bill for a unit combining high accuracy with complete field adjustability of as many as eight individual timed intervals. Although these timers can be supplied with preset cams to fit the needs of a present application, the added feature of adjustability makes them the ideal choice where the timing sequence may later be changed.

Operation

Applying power through an external sustained contact starts the timer, which continues to cycle until the control contact is broken. Full cycle time is the total time range of the timer specified, and may be selected from a large number of available ranges. If desired, the timer can be wired to perform one cycle and stop.

At the start of each cycle, the snap-acting SPDT load switches are in the initial positions specified (or established through adjustment) by the user. As the cycle progresses, each load switch is transferred by its operating cam to open or close its connected circuit at the required time and for the required duration.

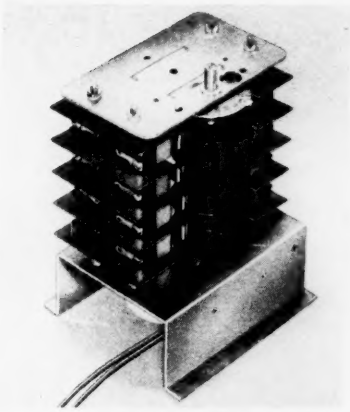
Timing Cam Adjustment

Each SPDT switch is operated by a double cam, one section to close the switch to one contact, the other to close it to the opposite contact. Depending on circuit wiring, either of these actions can "make" or "break" the load circuit. Each section of each cam is independently adjustable through a full 180°, without disturbing any other cam setting, by means of a small spanner wrench furnished with the unit. Adjustment is indicated on a dial which is marked in percent of total cycle time, permitting accurate selection of the desired "make" and "break" points for each load switch.

Features

TIME RANGES — From 1 cycle in 6 seconds to 1 cycle in 48 hours.

LOAD CIRCUITS — From 1 to 3 (Type 511) or from 4 to 8 (Type 521), each controlled by a totally-enclosed quick-make quick-break SPDT switch rated for 20 amperes at 125 or 250 volts AC (non-inductive).



Field-Adjustable Program Timer Type 521

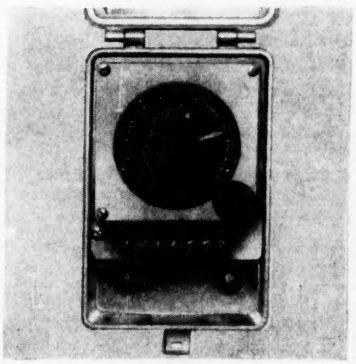
OPERATING TIME — Minimum operating time for each circuit is approximately 1/30 of total cycle time.

ACCURACY — At operating point of any one circuit, 1½°; between any two circuits, 3°.

MOTOR — Cramer high-torque synchronous, for 115 and 230 volts, 25, 50 and 60 cycles. Motors for operation on DC or at other frequencies are available in limited time ranges.

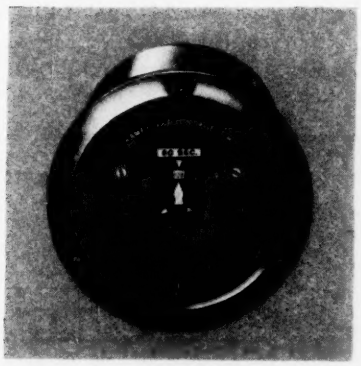
For detailed information and complete specifications, write Cramer Controls Corporation, Box 5, Centerbrook, Conn.

THREE MORE WAYS TO SOLVE YOUR TIMING PROBLEMS



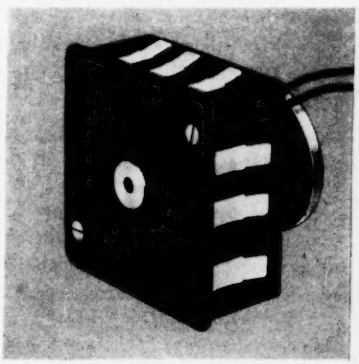
VARIABLE-CYCLE PULSE TIMER TYPE 650

Makes or breaks an electrical circuit for a fixed period or "pulse" of ½ second to 12½ hours, at continuously repeated intervals that are adjustable from ¾ second to 24 hours. By choice of load connection, control can be based either on the fixed pulse time or on the adjustable interval between pulses. Cycling period can easily be changed during operation.



ADJUSTABLE PERCENTAGE TIMER TYPE 610

Makes or breaks an electrical circuit for a variable percentage of a basic fixed cycle time. Desired percentage of total cycle time, for ON or OFF control of the timed device, is adjustable from 4% to 96% in steps of 1%. Total cycle-time ranges from 15 seconds to 24 hours. Internal connections can easily be arranged so that the load circuit is either closed or open for the indicated percentage of the full cycle.



CYCLING TIMER TYPE 571

Provides reliable and inexpensive control of repetitive switching for built-in applications. One through four poles, SPST or SPDT open-blade switches with contacts rated at 30 amperes, each controlled by a timing cam specially cut to user's requirements. 18 standard speeds from 1 rpm to ⅛ rpd, plus many special time ranges.

CRAMER CONTROLS

CORPORATION

Box 5, Centerbrook, Connecticut

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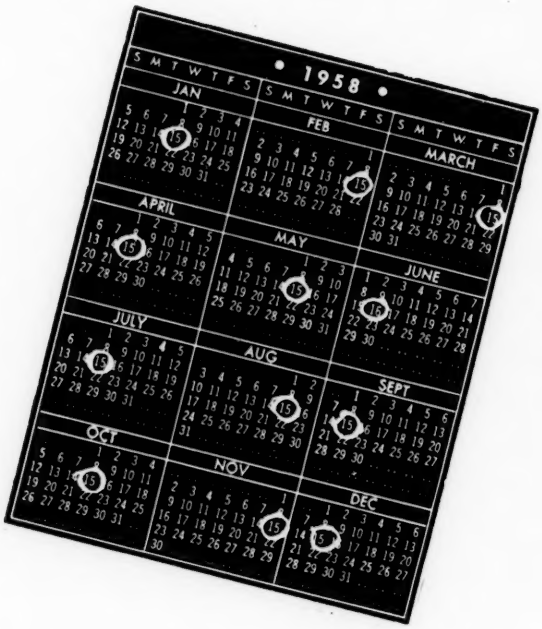

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June—*Numerical Readout*
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NEW BAILEY
Multi-Pointer Gage

...has twice as many indicators
...no taller than a telephone!

Now the popular versatile Bailey Multi-Pointer Gage has been reduced in size to conserve control panel space—without loss of easy *readability*.

Each new Multi-Pointer Gage Unit offers you these three choices to—

1. Measure and indicate draft, pressure, differential pressure and level.
2. Transmit above variables either pneumatically or electrically to remote indicators, recorders and/or controllers.
3. Receive and indicate any measured variables which may be transmitted pneumatically by standard SAMA ranges of 3-15 psig, or 3-27 psig.

FEATURES

Compact Size—Two large, easily-read 7″ scales in space only 4 inches wide.

Wide Range Selection—Standard ranges from 0-0.5 in. H_2O to 0-5000 psig available.

Choice of Standard Colors—Satin Black, Slate Gray, Moss Green, or Terra Tan may be selected as an exterior color at no additional cost.

Colored Scales—Scales available in white, red, green, blue, yellow, or orange.

Fluorescent Illumination—All gages have slideout unit containing bulb and starter for ease of maintenance.

Readily Accessible Adjustments—Zero adjustment made from front of gage. Other adjustments made from rear of gage.

Two-point Positive Mounting—Gage unit mounted with two clips . . . no holes to drill or studs to weld.

Unlimited Indications—Any number of basic two-indicator units may be placed side-by-side to provide indications of related factors. Each two-indicator unit is separately mounted.

For additional information, call your local Bailey District Office, or write us direct. G47-1

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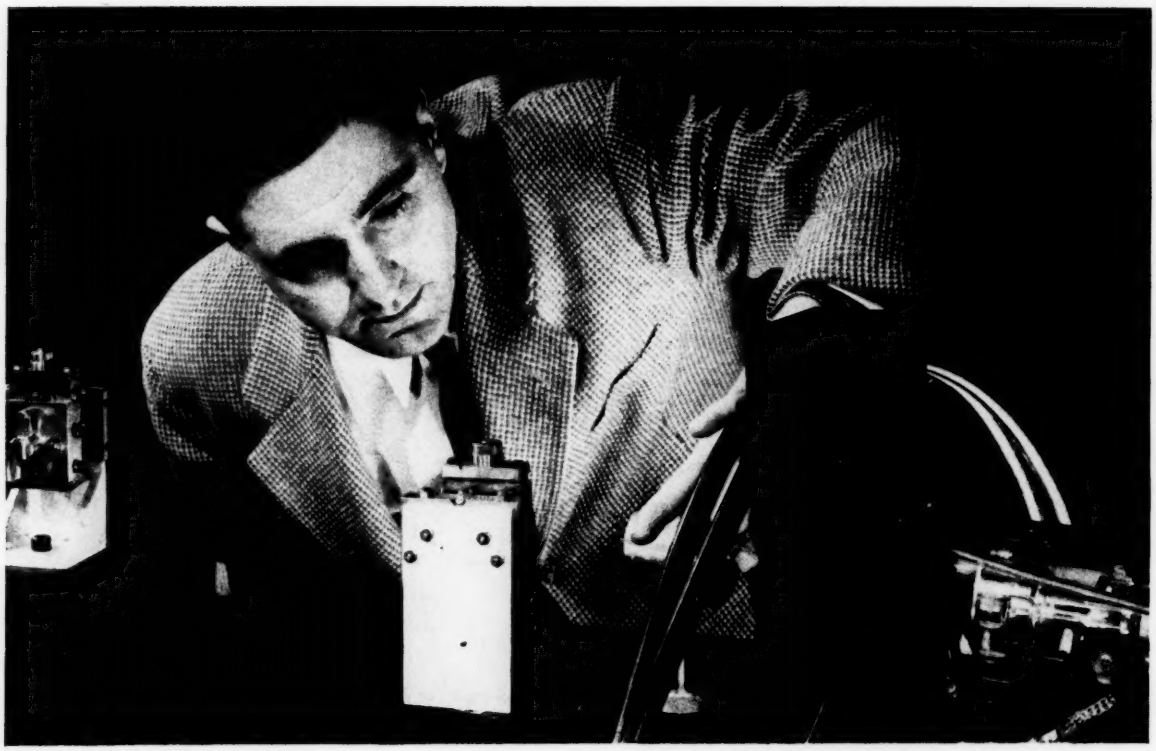
Instruments and controls for power and process

BAILEY METER COMPANY

1041 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

For more information circle **49** on inquiry card.



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For more information circle **50** on inquiry card.

Panhandle Pete

T. R. System Analyzer

Friends, are you confused over this issue of "Systems or Hardware" which has the industry agog? Are your ears sore from listening to all the pros and cons of the arguments? Does your mind reel with thoughts of the metaphysical wing-flapping you are asked to consider? Are your eyes cocked from looking at the flummery of systems? Have you ridden on the bandwagon of systems engineering until you have blisters on your seat of knowledge? Have you had to walk home from lectures on "Automation—The hope of the Future!?" Does *your* back hurt? Hmmmm? Well WESCO! does it again—with the T. R. System Analyzer.

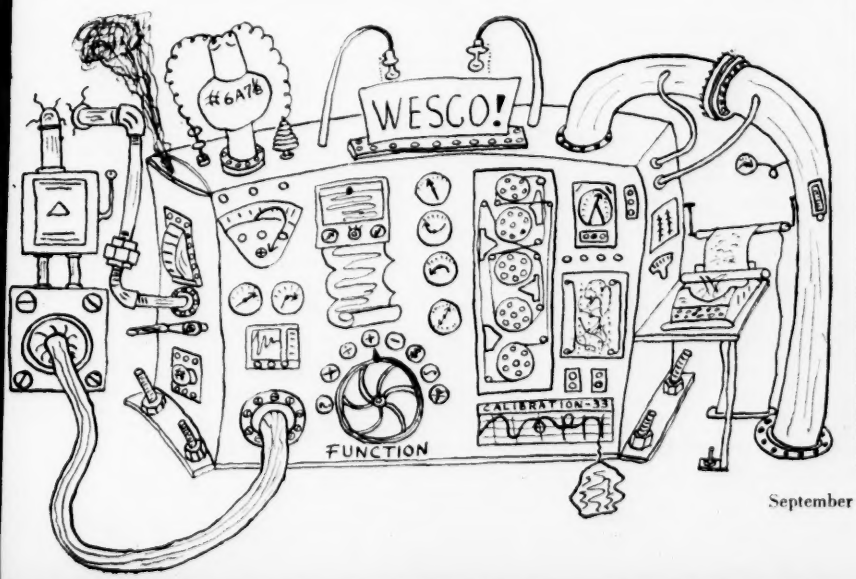
The first installation of the Model T. R. System Analyzer already has been made in the West Virginia Electronic Coke and Petroleum Company; all phases of management, production, labor, maintenance, profits and losses (losses? What am I saying?) will be scrutinized by the T. R.

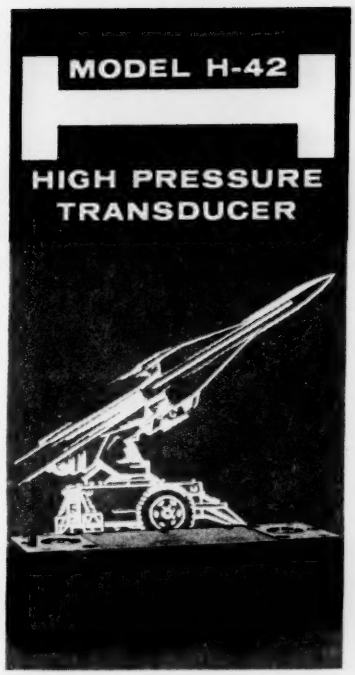
The sketch shown of the T. R. System Analyzer is published through the courtesy of Mr. Bus Wallace, Chief Engineer, WESCO! Usually our genial Salesmanager Waldo Klapsaddle handles these things, but Waldo isn't genial today nor is he in the office. (It seems Waldo purchased a rotary grass-cutter which worked so well in his yard that Waldo thought he'd try it out in his back pasture where there were some thistles to cut down. Everything went along pretty good until Waldo ran the mower over what he thought was a big ant hill at which time Waldo said "Everything turned brown." Ha, ha, ha! It turned out Waldo lost the ends of his toes and won't be out to work for some time. Waldo is also selling a cow.)

But, quoting Mr. Wallace in Waldo's absence: "Cuz, we are following the trend towards so-called packaged equipment. I am in a good position to know what our customer wants and he wants integrated systems, not components or problems. The problems he has: he wants answers, bang, bang, bang. Our problem is to give a reasonable amount of service in order to allow a modest amount of profit—say 3,456% to be exact. We have worked twenty years on this development. We now know so much that this new instrument was designed and built in 30 days.

It can be set into a plant, plugged in, a few simple connections made and, in a minute's time, be savings thousands of dollars. Featuring mechanical, pneumatic, hydraulic, electrical and electronic components plus vacuum tubes, gas tubes, NPN and PNP transistors, magnetic amplifiers, solid state, liquid state and gaseous state amplifiers as well as analog, digital, analog-digital, digital-analog, minimum-maximum decision circuitry, plus our amazing 780,000 word per micro-second encoder, this system analyzer is out of this world. If you don't see what you recognize, ask us because it's there someplace. At a price of $45,758,300.41 (including a spare tape and set of charts) we look forward to supplying American Industry with another 'first' in the line of new tools.

Panhandle Pete





In each Hawk missile launcher developed by Northrop Aircraft Inc., two Servonic H-42 pressure transducers provide damping in the servo systems which operate the azimuth and elevation controls. A radar impulse furnishes guidance and slews the missile carriage to the proper position for launch. The Servonic transducer senses the pending oscillation in the hydraulic system due to the inertia of the moving mass and applies a correction signal to the servo amplifiers controlling hydraulic pressure so that each oscillation is counteracted. This provides a stable motion as the platform is brought to rest in the correct firing attitude.

The use of the H-42 in the Hawk launcher servo systems is typical of the many application capabilities of Servonic pressure transducers in extreme environmental situations.

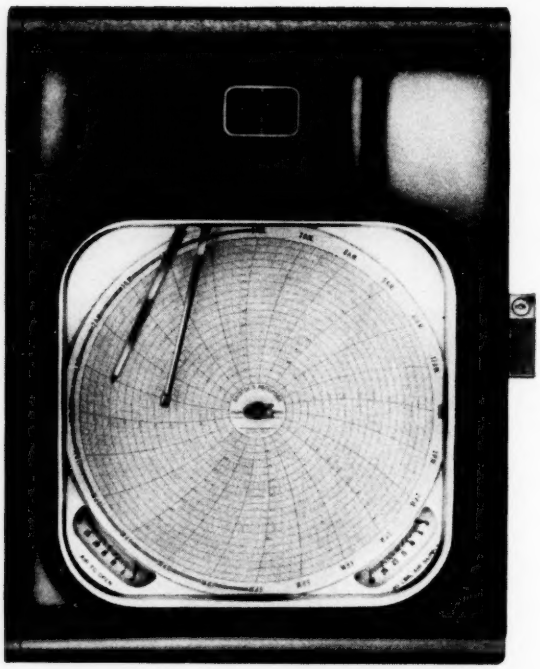
H-42 SPECIFICS:

Range: ±4,000 psid.
Linearity: ±0.5%.
Hysteresis: Less than 1%.
Resolution: 0.2%.
Vibration Effects: Less than 1% at 20g.
Shock: 30g.

Complete Details in
Technical Bulletin SI-581

SERVONIC
INSTRUMENTS, INC.
640 Terminal Way
Costa Mesa, California

For more information circle **51** on inquiry card.



Your newest man can operate and maintain this controller

He'll catch on quick to the Bristol Series 500 Controller without a complicated, lengthy training period.

In fact, your plant can have Bristol Series 500 Controllers, even if you don't have a formal instrument department at all. Many small instrument users are doing this today. Yet the 500's performance is such that one of the largest, most widely known chemical companies in the country just bought seventy 500's for its exacting processes.

Here are the big reasons the 500's a favorite with all instrument users, both large and small: (1) Basic simplicity of the operating mechanism; (2) Bristol measuring elements insure the utmost accuracy.

Another big simplification: You can exactly calibrate the Series 500 Controller with only one single adjustment, even after complete disassembly and reassembly with replacement of parts.

Get complete data on Bristol Series 500 Pneumatic Controllers now, before you order another instrument. Write for bulletin A 130, The Bristol Company, 113 Bristol Road, Waterbury 20, Conn. 8-19

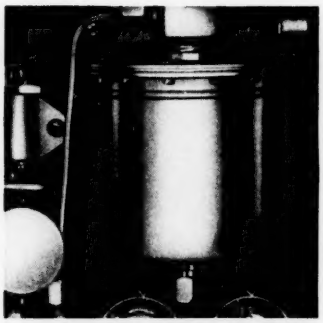
Several hundred standard models meet every process requirement including:

These problems:	These operating modes:
1. Cascaded control	1. Fixed narrow band (on-off)
2. Selective control	2. Proportional—to 100% and to 30%
3. Ratio control	3. Reset with wide band—to 400%
4. Time program control	4. Derivative (rate)
5. Pneumatic Transmission	5. Reset plus derivative

BRISTOL TRAIL-BLAZERS IN PROCESS AUTOMATION

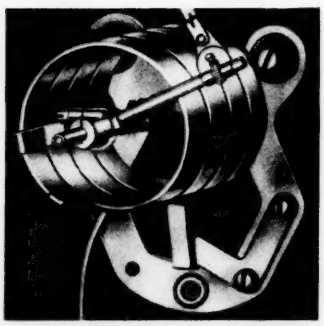
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **52** on inquiry card.

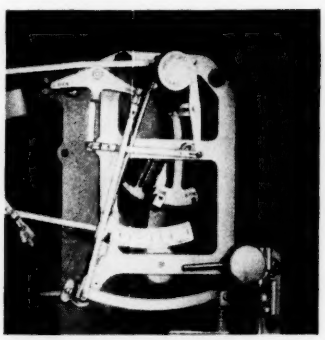


Reset Action Stops (in cylinder), another Bristol exclusive on reset models.

Zero Derivative Setting, exclusive with Bristol on derivative models.



Precision Bristol Measuring Elements insure accuracy.



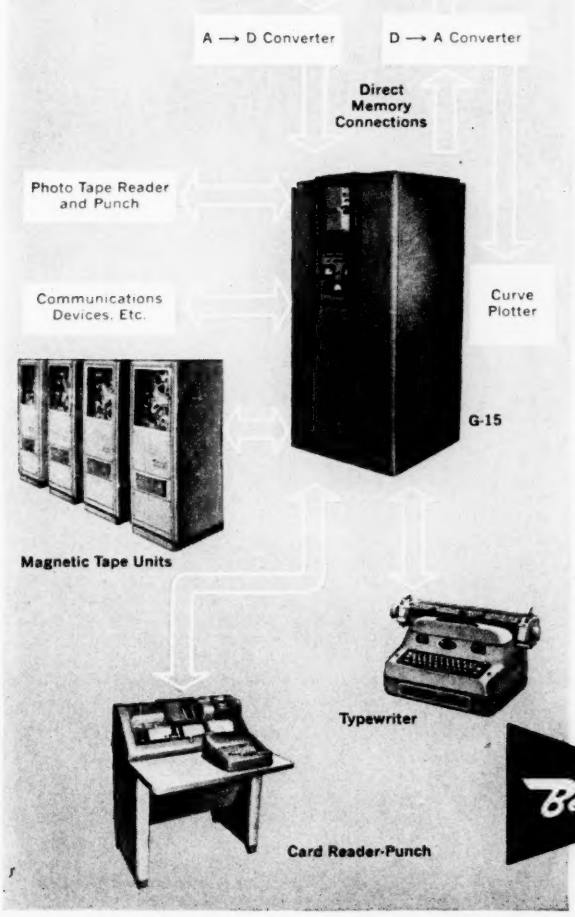
Built-in Calibration assures permanent accuracy of controller action.

Bendix G-15

the ideal computer for "on-line" data processing and control

TYPICAL SYSTEMS WHERE THE G-15 CAN BE USED

1. *Process controls*
2. *Missile tracking and impact prediction systems*
3. *Engine test stand data reduction and control*
4. *Wind tunnel data reduction and control*
5. *Real time position determination for mobile missile launching sites*
6. *Machine tool controls and many other open and closed loop systems*



In use *now*, as a part of several systems, the Bendix G-15 has proven itself the ideal digital computer for data reduction and control. Its high speed...versatile command structure... widely varied methods and means of input and output... small physical size...and its low cost, all contribute to the *reason* why the G-15 is being selected for use in more and more on-line applications.

The G-15 is the fastest general purpose computer in the low price field. For real-time control applications, this speed is often important. In at least one case the G-15 has been chosen for real-time computation where only a million dollar computer has ever been used before.

The versatility of the G-15's basic programming system contributes heavily to its ability in on-line applications. Commands are available for shifting with tally, extracting and assembling of words, overflow indication, branching, block data transfer, and many other special functions valuable in on-line use.

Perhaps of greatest importance is the computer's unique variety of input-output possibilities. The basic G-15 includes an electric typewriter for input-output and control, as well as a paper tape punch and magazine loaded high-speed photoelectric tape reader. Punched card, and magnetic tape units are available and all may be connected at the same time through the computer's buffered input-output registers.

Other devices such as A to D or D to A converters may be connected simultaneously or in place of the above mentioned accessories, and operated under control of the computer. Finally, information can be directly written on or read from the memory drum, under control of special external devices.

Note that all of these methods of input and output can be utilized without any modification of the computer. Connectors are provided on the rear of the G-15 for each type of input and output described.

If ruggedness is required, the G-15 can prove an enviable record. Two of them have been in use for well over a year bolted directly to the deck of a ship, and have shown a performance record to be envied by any computer based on solid ground. During a recent six months period the average up-time for all of the over 100 Bendix G-15's in the field was 95.4%.

The G-15 is compact, too, occupying just six square feet of floor space. Of course, it can be used as a powerful general purpose computer, as well as for on-line applications. A variety of simplified programming systems is available, including the renowned INTERCOM 1000, which can be used after four hours training or less.

The reasons are many...but the fact is that more and more G-15's are being leased or purchased for on-line use. If you would like to discuss your own requirements, we would be pleased to work with you. Write Department *J-6* for information.

If you are going to the ISA show, our specialists and the G-15 will be there in booths 1440-1541.

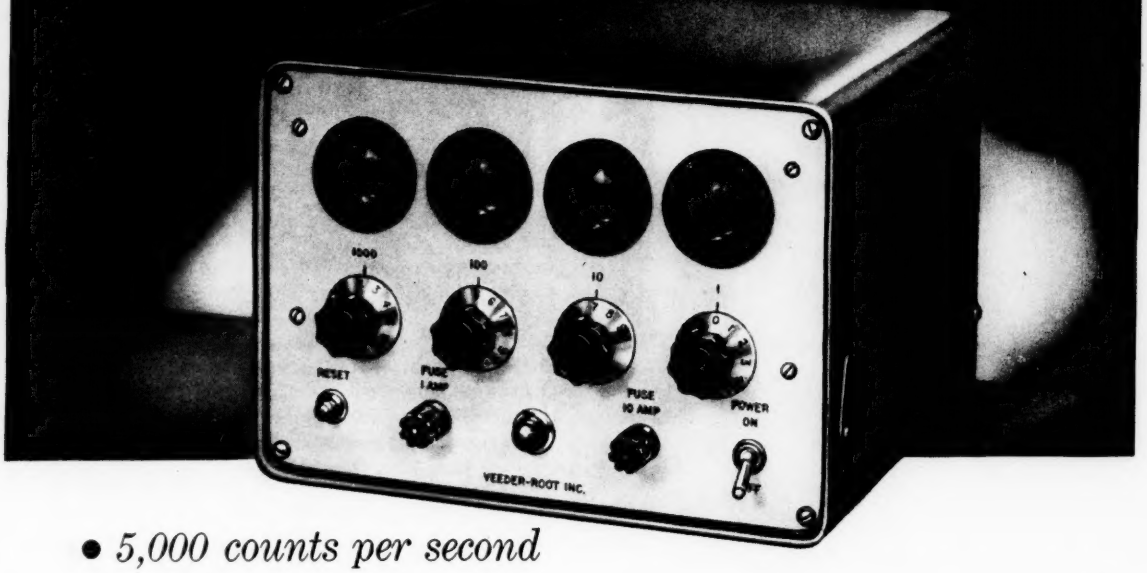
Bendix

DIVISION OF BENDIX AVIATION CORPORATION
LOS ANGELES 45, CALIFORNIA

For more information circle **53** on inquiry card.

NEW

TRANSISTORIZED PREDETERMINING COUNTERS



- *5,000 counts per second*
- *Instantaneous recycling*
- *Increased reliability*
- *Industrial design*

A versatile group of transistorized production counters designed for industrial applications. Any number of decades can be furnished depending upon your requirements.

Can be operated by non-technical help merely by setting the selector knobs to the pre-set quantity within the range of the instrument. These counters are ideal for batch control, sequential predetermining, or accurate length control in such applications as packaging, coil winding, slitting, stacking and material handling.

The use of transistors means that heat — the enemy of reliability — has been eliminated. This reduces warm-up time and increases dependability. Printed circuits and simplified wiring further insure long trouble-free operations.

Standard counters are completely enclosed in attractive industrial cases, but can also be supplied without enclosures for panel mounting. A photo head to actuate these counters can be furnished in many configurations. Batch totalizers with push-button reset and special modifications of basic components can be furnished on request.

This is your complete package for predetermining counting at high speeds. Send for your copy of the new specification bulletin outlining the complete range of the series 1604 counter line today.

Veeder-Root
INCORPORATED
Hartford 2, Connecticut

Hartford, Conn. • Greenville, S. C. • Altoona, Pa. • Chicago • New York
Los Angeles • San Francisco • Montreal • *Offices and Agents in Principal Cities*

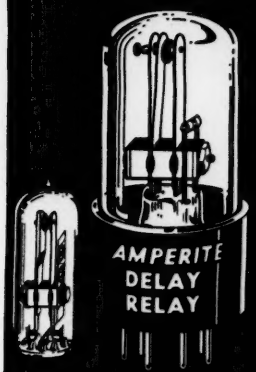
For more information circle **54** on inquiry card.

AMPERITE PREFERRED

by design engineers—because they're

MOST COMPACT • MOST ECONOMICAL

SIMPLEST • HERMETICALLY SEALED



Thermostatic DELAY RELAYS

2 to 180 Seconds

Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.

Hermetically sealed. Not affected by altitude, moisture, or climate changes.

SPST only—normally open or closed.

Compensated for ambient temperature changes from —55 to + 70 C. Heaters consume approximately 2 W. and may be operated continuously. The units are **rugged, explosion-proof, long-lived,** and—**inexpensive!**

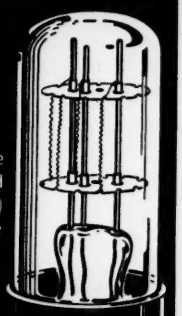
Also — **Amperite Differential Relays:** Used for automatic overload, under voltage or under current protection

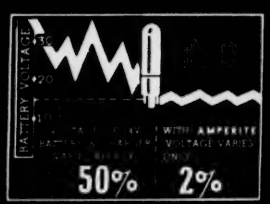
TYPES: Standard Radio Octal, and 9-Pin Miniature . . . **List Price, $4.00.** Standard Delays

PROBLEM? Send for Bulletin No. TR-81

BALLAST REGULATORS

Amperite Regulators are designed to keep the current in a circuit **automatically regulated** at a definite value (for example, 0.5 amp.) . . . For currents of 60 ma. to 5 amps. Operate on A.C., D.C., or Pulsating Current.





Hermetically sealed, they are not affected by changes in altitude, ambient temperature (—55 to + 90 C.), or humidity . . . Rugged, light, compact, most inexpensive . . . . . **List Price, $3.00.**

Write for 4-page Technical Bulletin No. AB-51

AMPERITE CO. Inc., 561 Broadway, New York 12, N. Y.

Telephone: CAnal 6-1446

In Canada: Atlas Radio Corp., Ltd., 50 Wingold Ave., Toronto 10

For more information on Delay Relays circle **149** on inquiry card.
For more information on Ballast Regulations circle **55** on inquiry card.

INSTRUMENT ENGINEERS . . .

here's a money-saving tip on small valves

You can stop worrying about heavy-handed operators ruining the stem points and seats on your small valves when you install Hoke's new 270 Series bar stock valves with plastic pointed stems. Let them "tighten down" all they want, because these long-wearing nylon or corrosion-resistant Kel-F tips have taken 700 cycles of operation at 3500 psi using twice the normal closing force—and the valve did not leak across the seat. They'll save you money three ways—cutting valve replacement, down-time and maintenance.

Use this new Hoke valve for vapor or vacuum leak-tight closure, in service up to 5000 psi. It also minimizes opening pressure surges, and meets applicable MIL specs for use on high pressure compressors. Available in ⅛" or ¼" sizes, globe or angle pattern, with O-ring or Teflon packing. All valves can be panel-mounted.

Complete information is yours on request. Write us today.

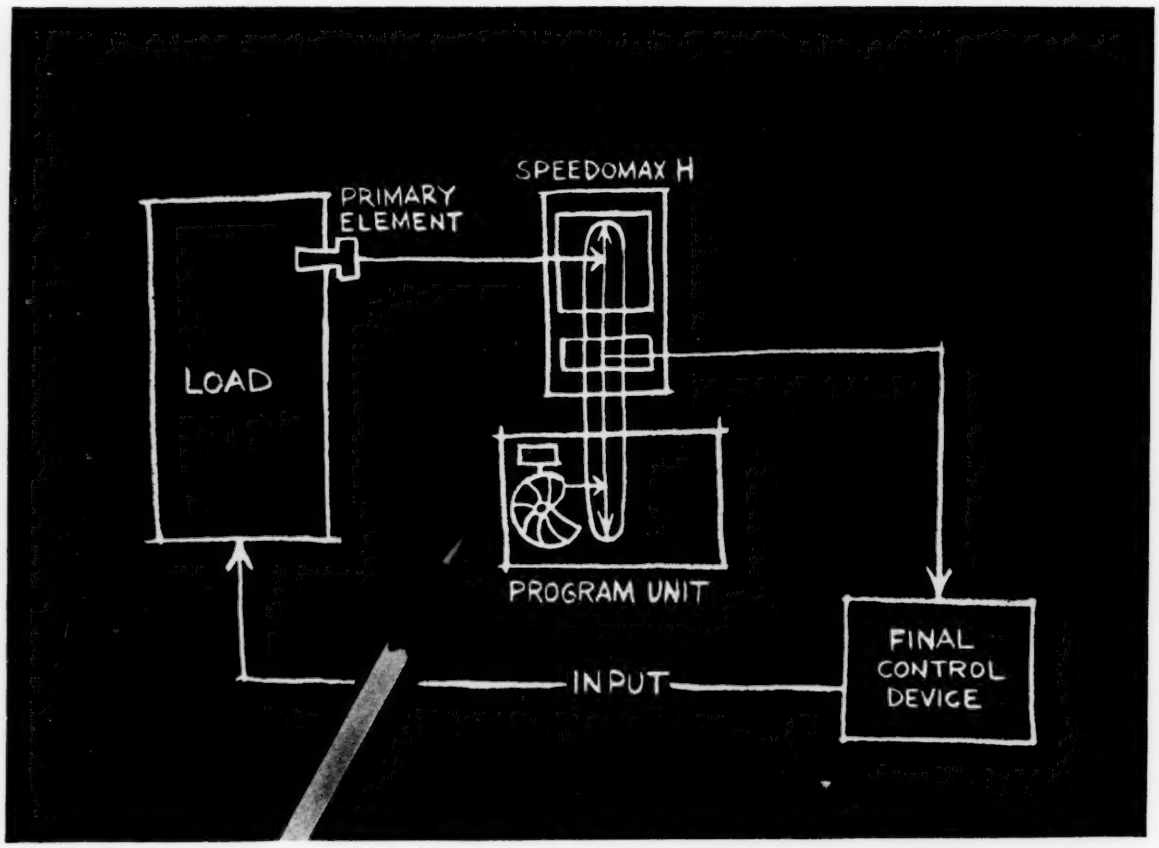
Why buy big when you can buy small

HOKE

HOKE INCORPORATED
FLUID CONTROL SPECIALISTS
31 Piermont Rd.
Cresskill, N. J.

Visit Hoke's Booth #1532 at the ISA Show, Sept., 15-19

For more information circle **56** on inquiry card.



Reproduce your time-temperature cycles exactly with L&N cam-type program control

At the flip of a switch you can heat . . . soak . . . and cool at a preset rate for a preset time with L&N's improved cam type program control! Whether your program is linear or non-linear, this control will continuously regulate input to reproduce *your* cycle . . . again and again.

Heart of the system is the program unit. Essentially it's a motor-operated cam and a control slidewire. The cam is calibrated . . . making it extremely easy to lay out and cut to any time-temperature cycle. Changing a cam to meet a new program takes only a minute. For additional flexibility, the unit has seven standard speeds . . . permitting a multiple number of programs.

Other elements in the control system include a primary element, a Speedomax® recorder and associated control relay, and a final control device. Any change detected by the primary element and measured by the recorder is checked by the program unit, which regulates the final control device to keep the process on cycle.

Also available is a motor-operated front setter type of program control. Recommended for linear programs only, this system offers great flexibility within the range selected.

Both types are available for Two-Position or proportioning control . . . will regulate input to electric or fuel-fired furnaces.

Can your *process benefit from programmed heating and cooling? If so, it'll pay you to investigate L&N program control. For more information, call your nearest L&N office, or write 4955 Stenton Ave., Philadelphia 44, Pa. Ask for Data Sheet ND46-33(4).*

LEEDS NORTHRUP
Instruments Automatic Controls • Furnaces

For more information circle **57** on inquiry card.

Canadian Industry -its likes, needs and attitudes

Report on the market for industrial measuring and recording apparatus in Canada, as revealed by an independent survey.

MICHAEL K. SHELLEY
Toronto 17, Ont.

PHILIPS ELECTRONICS INDUSTRIES of Toronto, newly entered into the field of industrial measuring and recording apparatus, recently mailed 1450 questionnaires to Canadian industries utilizing process control instrumentation. The replies were interesting, highly informative and in some cases almost startling.

The past ten years have seen Philips rise as a leader in the field of scientific research apparatus in Canada. Philips' X-ray spectrographs and diffractometers are presently in use in most of Canada's major universities, and their electron microscopes are well known.

Philips recently announced an entry into the industrial equipment market. An impressive build-up of instruments over the past two to three years now enables Philips to offer apparatus for measuring, recording and controlling temperatures, pressures, strain, pH, etc. Custom installations are also being offered for electronic weighing and continuous X-ray spectrographic analysis.

One of the important facts that Philips Electronics Industries wished to know was "what technical journal serves the field of process control and instrumentation best?" Of the dozen journals mentioned in the replies, *Instruments and Automation* was well out in front with *more than 60% of the first place votes.* The remaining 40% of the votes was divided between ten other publications.

The survey was aimed at Canada's major industries utilizing process control apparatus, these being the mining, pulp and paper, chemicals and petro-chemical industries.

Questions and Answers

The following is an analysis of the answers to the specific questions in the Philips questionnaire:

Question 1—"Of the many instrument catalogues you receive, which companies produce the most useful?"

1. Minneapolis-Honeywell Regulator Co.
2. Foxboro Company.
3. Taylor Instrument Companies.
4. Bailey Meter Company.
5. Mason-Neilan Div. Worthington Corp.
6. Fischer & Porter Company.
7. Leeds & Northrup Company.
8. Bristol Company.
   Many others were mentioned.

Question 2—"In your opinion what technical journal serves the field of process control instrumentation best?"

1. Instruments and Automation
2. ISA Journal
3. Control Engineering
4. Instruments & Process Control (U.K.)
5. Pulp and Paper Magazine of Canada
   Taylor Technology
   National Petroleum News
   Oil and Gas Journal
6. Instrument Engineer (U.K.)
   Industrial Engineering Chemistry
   Engineering Journal (U.K.)

Question 3—"What new products in the instrumentation field would you like to see developed?"

	No. of users who made suggestion.
Consistency regulators (for stock particularly)	15
A rapid and consistent method for measuring moisture in wood shavings or chips without drying the chips	5
Moisture control of paper sheets	5
Automatic continuous freeness tester for (measurements of) pulp and paper stock	4
More rugged pH measuring instruments to operate at a temperature and pressure of 475° and 700 psi	5
Electronic combustion controls	6
Electrically operated control valves	10
Electronic temperature controllers	8
Flow, pressure and density controllers	20

. . . trend toward electronic controllers

Question 4—"Do you consider the trend is towards electronic or pneumatic controllers?"

Electronic controllers	60%
Pneumatic controllers	17%
Other opinions: "Both will continue to have applications; where accuracy over-rides cost consideration the trend is towards electronic instruments; however, for general pressure and temperature controllers pneumatic instruments, at a lower cost than electronic, serve their purpose well."	6%
No opinion	17%
	100%

Question 5—"What conventions (technical meetings) do your company engineers attend most frequently?"

1. Canadian Pulp and Paper Association
2. Instrument Society of America
3. Technical Association of Pulp and Paper Industry
4. Institute of Radio Engineers
5. Engineering Institute of Canada
6. American Chemical Society
7. American Society of Mechanical Engineers
   American Institute of Electrical Engineers
8. Canadian Institute of Mines and Metallurgy
9. Canadian Power Show
10. Canadian Institute of Sewage and Sanitation

Question 6—"What do you consider the optimum interval to see a manufacturer's representative?"

Monthly	12%
Quarterly	65%
Semi-annually	18%
Between monthly and quarterly	5%

Question 7—"Do you prefer graduate engineers as manufacturers representatives?"

Percentage favouring graduate engineers	80%
Percentage voting "no"	20%

Those voting "no" could actually be placed in a "no preference" category because in almost every case an explanation was added to the effect that they are interested only in having a representative who has wide experience and who is thoroughly familiar with the product. There were also a few qualified "yes" votes, five respondents pointing out that it is the *experience* that matters in this regard.

Question 8—"Do you consider factory training courses desirable for instrument technicians?"

Yes	90%
No	5%
No opinion	5%

Question 9—"To what extent does the Canadian content of the instrument influence your purchasing policies?"

To a great extent	40%
A minor consideration	47%
Not at all	13%

Three replied that they placed great emphasis on Canadian manufacture because of availability, spare parts and service; two mentioned that Canadian manufactured instruments take priority only if the price is "right"; one company explained that, regardless of where the product comes from, the factors that influence their purchasing policy are price, quality, reliability and delivery.

Question 10—"Do you prefer to buy either complete systems including engineering, or components to be introduced into systems?"

1. Components to be introduced into systems	76%
2. Complete systems including engineering	24%

A few replied that their preference would be conditioned by the type of installation. For new systems (2) is preferable; but for improvements to existing systems (1) is considered better.

Question 11 asked for customers' preferences as to (a) factory wired panels or (b) to do the work themselves.

Factory wired panels	60%
Do work themselves	40%

Question 12 inquired whether adequate application engineering information is received from equipment manufacturers.

Yes	73%
No	27%

Question 13—"Has the service that you have needed from instrument firms in the past been satisfactory?"

Yes	75%
No	25%

Question 14—"Has your company any interest in service contracts on a routine basis?"

Interested	26%
Not interested	74%

Question 15—"What percentage of the total dollar value of your companies' process control equipment goes to instruments with applications for flow, pressure, temperature, level, etc?"

	Percentage of total value of companies' process control equipment.
Flow	20%
Pressure	20%
Temperature	30%
Level	20%
Other (pH, mechanical strain, moisture, radiation)	10%
	100%

YEAR 'ROUND BONUS!

You Get More Than Just a Valve When You Buy BS&B's Super 70

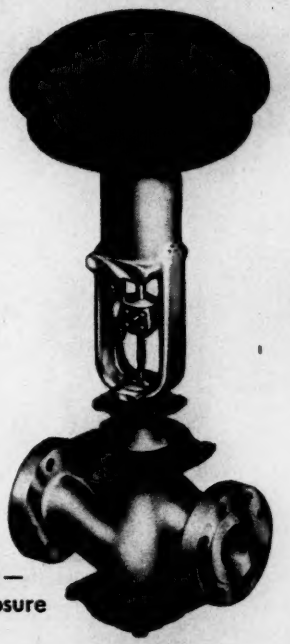
Specification of BS&B Super 70 Diaphragm Control Valves on your next job will assure you of getting all of the following:

1. High Quality Product . . . The BS&B Super 70 Diaphragm Control Valve has high efficiency and stability. In addition to thousands of hydraulic flow tests performed in the laboratory, analysis of operating data gathered from Super 70's on stream in customer plants substantiate their excellent performance.

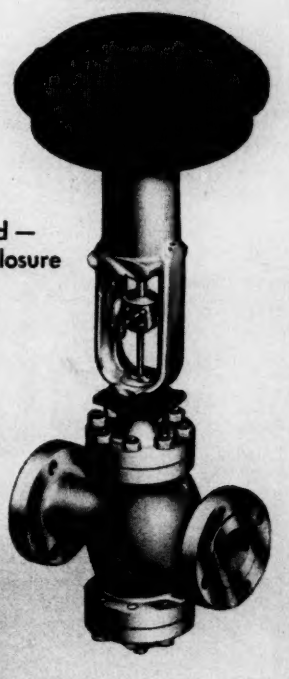
2. Application Engineering . . . Today's complex processing problems require detailed analysis to determine proper instrumentation and control applications . . . accurate control valve sizing. This is a regular service to Super 70 customers.

3. Start-up Assistance . . . After helping customers select the right valve for a specific job, BS&B follows thru by assisting at plant start-up time.

4. Time-saving Scheduled Maintenance . . . With the patented clamp ring—float ring closure, valve maintenance can be done in a fraction of the time required by conventional type valves . . . an economic must in future valve specifications.



Clamp Ring —
Float Ring Closure



Flanged —
Gasket Closure

BS&B Super 70 Valves are available in either clamp ring—float ring, sealed bonnet or flanged-gasketed body closures. Whichever type you choose, when they're "on stream" you'll *know* that they're exactly right for the job.

Call your nearest BS&B office or representative *now* to discuss your present and future valve requirements. Or if you prefer, write for detailed information.

OVER 60 YEARS
BS&B
ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

BLACK, SIVALLS & BRYSON, INC.

Controls Division, Dept. 4-V9

7500 East 12th Street

Kansas City 26, Missouri.

For more information circle **59** on inquiry card.

Response of Combination

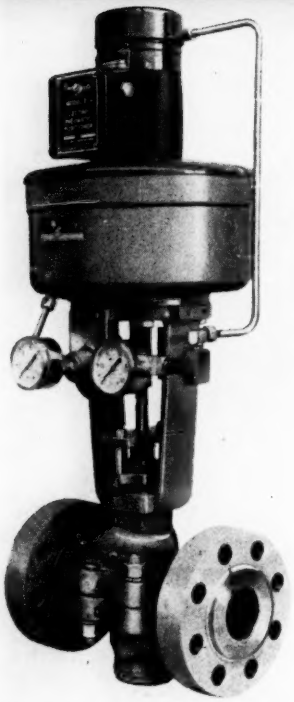


FIG. 1. CONO-FLOW Model E electropneumatic positioner.

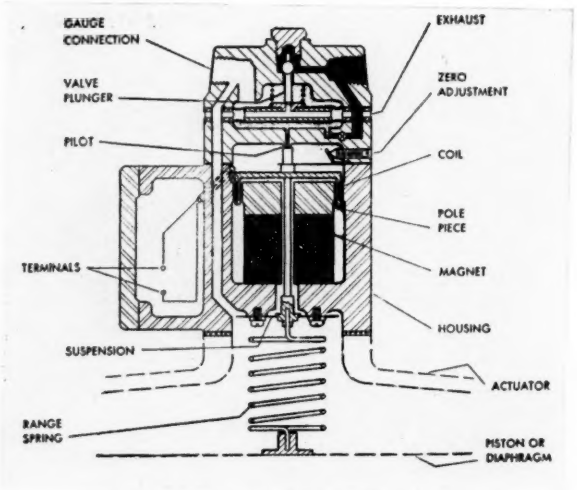


FIG. 2. MOORE Model 75 E/P positioner.

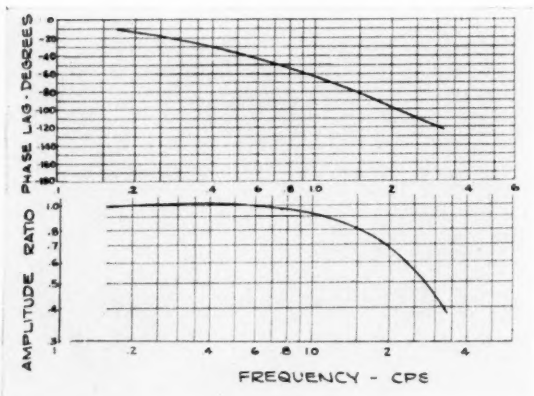


FIG. 3. RESPONSE of Model 75 E/P on an 8" diameter Conoflow B-53 cylinder actuator using Moore Model 69-3 reversing relay for cushion loading. Supply pressure is 25 psi; mean output pressure is 9 psi; sinusoidal input-current amplitude is 0.1 ma (2.5% full scale); displacement volume is 50 cu in; tare volume is 5 cu in; mean piston position is ½" from top stop; piston stroke is 1" for 0.5 to 5 ma input; actuator friction is 3% full scale.

IN DESIGN AND ANALYSIS of the closed-loop control situation it is desirable, if not necessary, to express each element of the loop in mathematical form if the system is to be investigated analytically, either mathematically or by simulation. A useful way for such expression is by transfer function (an expression relating the output of a device to its input).

In process control loops the final element—the valve and its actuator—is a critical component because most controllers and primary elements can operate faster than the final element, hence the valve and its actuator often become the limiting factor in the loop response. This emphasizes the importance of expressing the valve and actuator in mathematical form.

The *combination* valve actuator (one that uses a combination of pneumatic, hydraulic, or electric techniques) is a particularly important element in such analysis because combination techniques are used primarily to obtain premium dynamic response. It follows that the response should be available in some form susceptible to analytical technique.

Manufacturers of combination valve actuators were asked to express their actuators in mathematical form for use in analysis. Here are the replies—some mathematical, some only verbal, most by curves.

These replies are significant. They show that most valve manufacturers are aware of the importance of mathematical expression—but that the form of expression has not been standardized, nor have standard load conditions been accepted.

There should be little difficulty in removing these two roadblocks to more rapid development of the process-control-loop art. The following is offered as a survey of the present state of the art in the hope that

Valve Actuators

it will stimulate groups interested in process instrumentation analysis to press for (1) a standard method of expressing the dynamic response of valve actuators under (2) a standard set of load conditions. The data herein will be of value also to users of final control elements in process control loops.

Conoflow Model E Electropneumatic Positioner

The Conoflow Model E electropneumatic positioner (Fig. 1) uses the Moore Products Model 75 E/P positioner (Fig. 2), which has been adapted for use with the control systems of Leeds & Northrup; Manning, Maxwell & Moore; and Swartwout.

Fig. 3 shows the response of the Model 75 E/P Positioner mounted on an 8"-diameter Conoflow B-53 cylinder actuator.

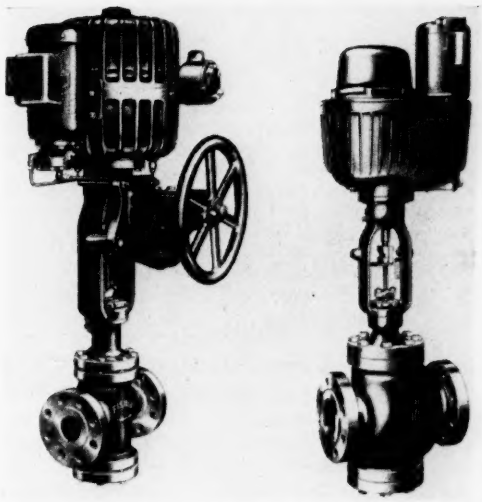


FIG. 4. FISHER Types 340 (left) and 350 (right) electrohydraulic actuators.

Fisher Governor Types 340 and 350

Fisher electrohydraulic actuators(Fig. 4) are self-contained electrically-operated valve actuators that perform without the use of electronic amplification, using only a single force motor to control the hydraulic pilot. The pilot systems use simple nozzle-flapper combinations to control hydraulic pressure (Figs. 5 and 6).

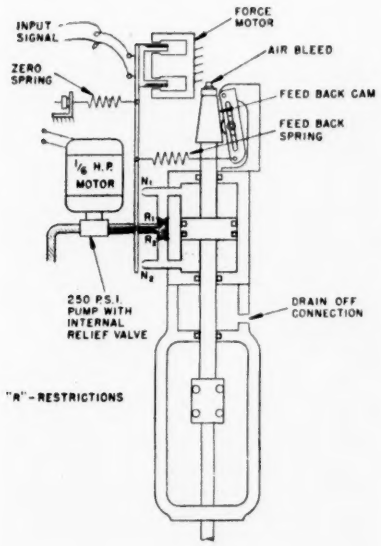


FIG. 5. FISHER Type 340 uses force motor to position flapper-nozzle unit N1-N2, which controls 250-psi hydraulic fluid to cylinder positioner.

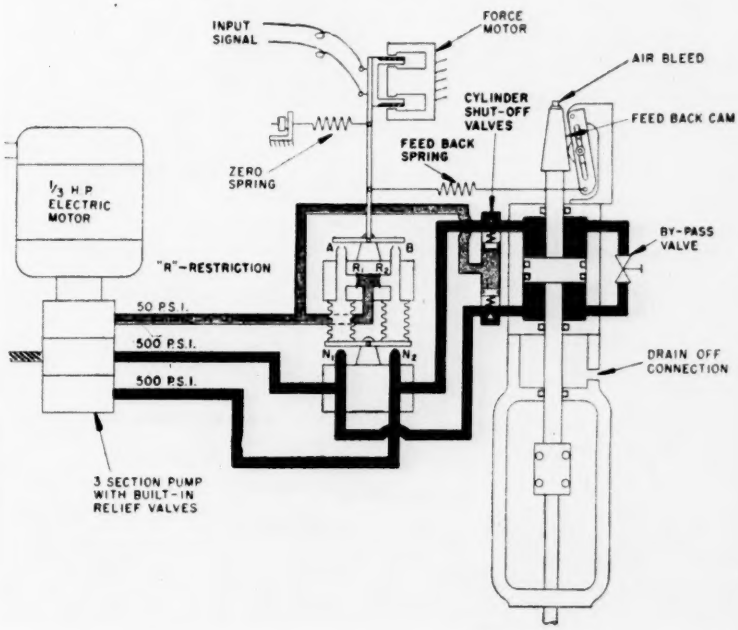


FIG. 6. FISHER Type 350 uses force motor to position upper flapper-nozzle A-B, which in turn positions flapper-nozzle N1-N2, which in turn controls 500-psi hydraulic fluid to cylinder positioner.

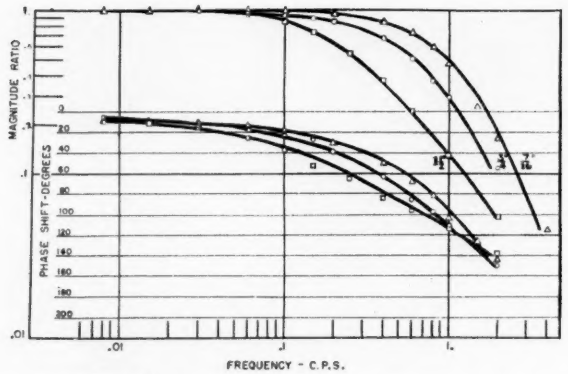


FIG. 7. RESPONSE of Type 340 topwork; 10-50 ma into 380-ohm (Foxboro) coil for travels indicated on curves; 5% input amplitude at 30-ma mean level. Response will vary with different coils.

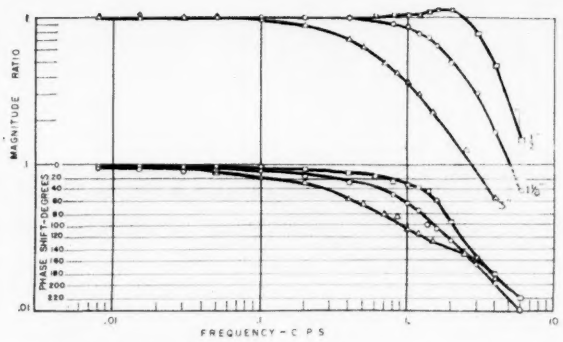


FIG. 8. RESPONSE of Type 350 topwork; 1-5 ma into 7900-ohm (Swartwout) coil for travels indicated on curves; 5% input amplitude at 3-ma mean level. Same response applies to all coils because of hydraulic amplifier between coil and cylinder of actuator.

Two sizes are available. Type 350 has a maximum stem thrust of 2000 pounds and is available for use on valve sizes ½" to 16" with strokes from ½" to 3". Type 340 is designed to be used on average control jobs; it has a maximum stem thrust of 600 pounds and is available for use on valve sizes ½" to 4" with strokes from 7/16" to 1½".

Performance curves are shown in Figs. 7 and 8.

Performance specifications are as follows:

	Type 350	Type 340
Stroking Speed	0.37"/sec	0.1"/sec
Max Stem thrust	2000 lbs	600 lbs
Phase Response (cps at which 90° phase shift occurs)	1.9 for ½" stem travel; 1.5 for 1⅛" stem travel, 0.8 for 3" stem travel	0.7 for 7/16" stem travel; 0.56 for ¾" stem travel; 0.44 for 1½" stem travel

The *transfer functions* for the two actuators and for a given stem movement are as follows:

Type 350 with 1⅛" stem travel:

$$T(s) = \frac{121}{s^2 + 20s + 121}$$

Type 350 with 3" stem travel:

$$T(s) = \frac{37.5}{s^2 + 17.5s + 37.5}$$

Type 340 with ¾" stem travel:

$$T(s) = \frac{20.4}{s^2 + 13.7s + 20.4}$$

Type 340 with 1½" stem travel:

$$T(s) = \frac{10}{s^2 + 11s + 10}$$

Comments

"The attached curves covering frequency response constitute the only mathematical information we have."

"We do not have available any transfer function or mathematical description nor have we prepared any data on response specifications."

"Note that in the case of the pneumatic-hydraulic positioner, the transfer function will vary with the amplitude of peak to peak input. For this reason it is generally better to make use of the frequency response curve than to attempt to pin it down mathematically."

"We find that we are not able to present a mathematical discussion of our control valve in a manner which we feel properly describes the operation of the actuator. Incidentally, we do not feel that the published data we have seen thus far on the various actuators does a proper job of describing the operation. The data presented has been either limited to a no-load condition or in some manner so that it does not really correctly give a comparison of actual performance."

"We have not reduced the response and signal performance of our actuators to a mathematical analog."

"It is possible for us to calculate the transfer function of any of our actuators, under a given set of conditions. However, such a mathematical description would not be satisfactory for system analysis unless the test conditions were duplicated in the system. The transfer function of any power actuator is affected not only by the amount of work that it is required to handle, but also by other factors such as the relative physical position of the actuator versus the instrument air signal. All of these factors would have to be clearly defined prior to any tests. . .If you have established any standards for your own purposes, we will be happy to select one of our actuators and provide a transfer function in accordance with these standards."

The given transfer functions are dimensionless. However, if it is desired to obtain the function in units of inches per ma, the transfer function should be multiplied by the total stem movement divided by four. The reason for the division by four is because the above actuators are supplied with a coil for a 1-to-5 ma input, or a 4-ma operating range.

GPE Controls Electrohydraulic Actuators

GPE Controls* offers the RD684 and RF697 (Fig. 9) electrohydraulic valve actuators, both of which are based on jet-pipe control of hydraulic fluid to a piston actuator (Figs. 10 and 11).

The *transfer function* of the 684 is:

$$K/(0.2D + 1)$$

where K = 0.125 to 0.5 inch/milliampere; D is the differential operator d/dt.

The 684 is down 3 db with 45° phase shift at 5 radians/sec.

Response specifications:

Valve Stem Stalling Thrust: 1000 lb with ¼ hp electric motor; 1500 lb with ½ hp motor.

Valve Stem Speed: 0.7"/sec no load (¼ hp); 0.9"/sec (½ hp)

Valve Stroke: ¼ to 2 inches

Frequency Response: About 0.7 cps in standard models.

The *transfer function* for the 697 is:

$$K/(D + 1)$$

where K = 0.125 to 0.375 inch/milliampere. The 697 is down 3 db with 45° phase shift at 1 radian/sec.

Response specifications:

Valve Stem Stalling Thrust: 235 lb.

Valve Stem Speed: 0.17"/sec no load.

The transfer functions are for production units. Variations in dimensions within acceptable tolerances can affect the time constant of these (as well as any) valve actuators. The transfer function is for no load and will be affected by the addition of inertia, friction, or other types of loading.

Different springs are used for various stroke ranges; this causes some deviation from the average time constant that will be no greater than ±50% of the stated value.

Hagan Pneumohydraulic and Electrohydraulic Positioners

The Hagan *pneumohydraulic* positioner BM-435978 (Fig. 12) has the response shown in Fig. 13.

Hagan *electrohydraulic* positioners are available in two series—Model 80 and Model 600. Both use a magnetic motor driven 2-stage hydraulic valve (Fig. 14). The Model 80 develops up to 20 useful control hp; the Model 600 up to 150 useful control hp.

The *transfer function* of the Model 80 (from coil input to high-pressure valve-motion output) is:

$$\frac{0.1s + 1}{(0.02s + 1)^3\,(0.01s + 1)^3}$$

* formerly Askania Regulator Company

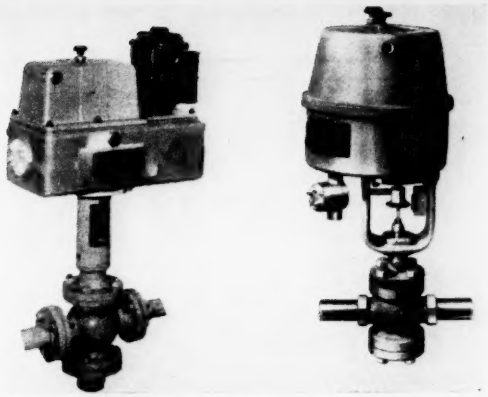


FIG. 9. GPE CONTROLS electrohydraulic actuators RD684 (left) and RF697 (right).

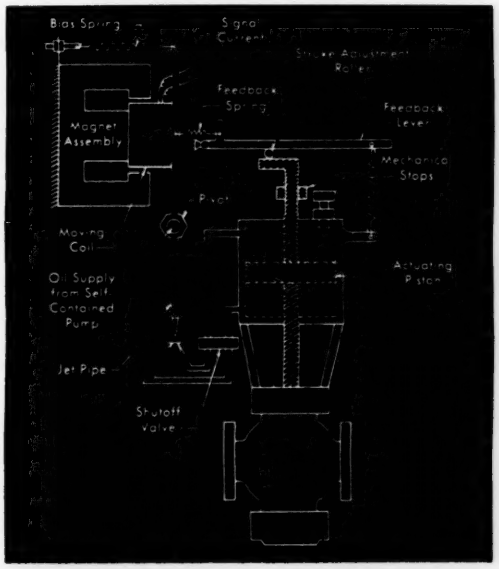


FIG. 10. OPERATION of the GPE 684 EHVA. Input signal moves jet-pipe relay that controls hydraulic fluid to cylinder.

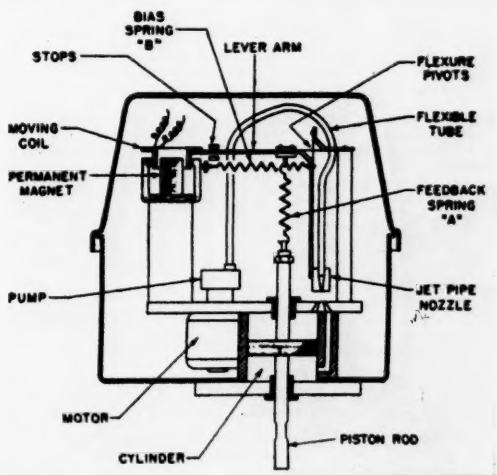


FIG. 11. GPE 697 is similar to the 684 in principle.

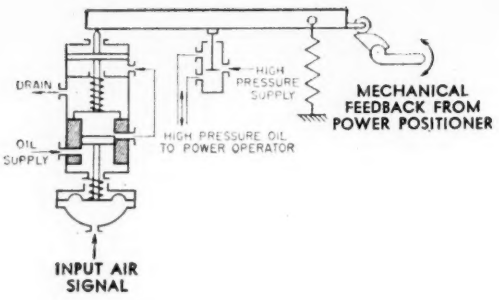


FIG. 12. HAGAN pneumohydraulic positioner uses 2-stage pilot to produce high-output force. The high-pressure supply is 1800 psi; the low-pressure 200 psi.

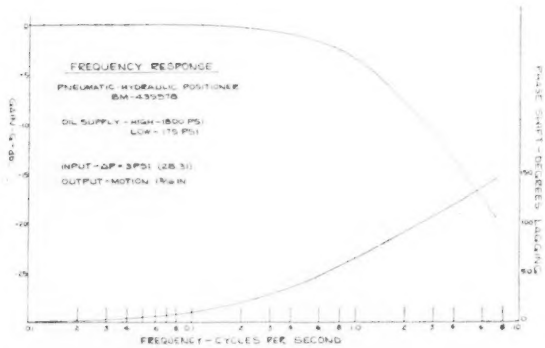


FIG. 13. RESPONSE of Hagan pneumohydraulic positioner BM-435978.

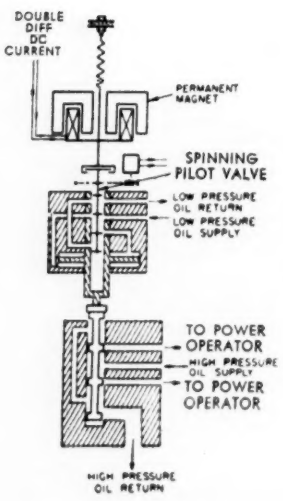


FIG. 14. HAGAN electrohydraulic pilot valves use 2-stage hydraulic pilots.

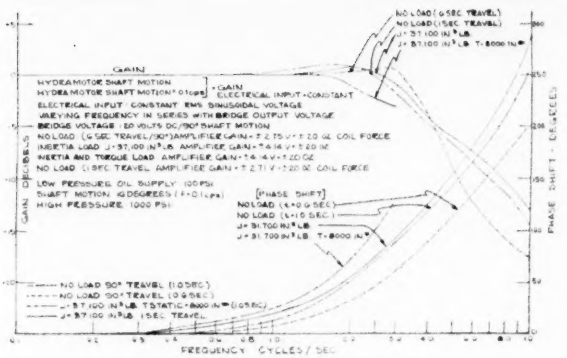


FIG. 15. RESPONSE of Hagan Model 80 driving a 5x10 hydramotor.

The *transfer function* of the Model 600 is:

$$\frac{1}{(0.08s + 1)\ (0.008s + 1)}$$

The response of the Model 80 and Model 600 driving a 5x10 Hydramotor (rotary hydraulic actuator) is shown in Figs. 15 and 16.

MM&M Electropneumatic and Electrohydraulic Actuators

The American-Microsen Series 132 electropneumatic valve positioner of Manning, Maxwell & Moore (Fig. 17, left) mounts on all standard pneumatic valves and positions the valve stem directly proportional to a d-c signal. The signal input controls the flapper action of an air relay which is supplied by a source of regulated air of up to 35 psi.

Response specifications are:

Input Signal: 1.0 to 5.0 ma dc or 0.5 to 5.0 ma dc.

Output Pressure Range: 3 to 15 psi or 3 to 27 psi (other ranges available on order).

Supply Pressure: 18 to 20 psi or 30 to 35 psi

Valve Stroke: ¼" to 3".

Speed of response: 3 sec full stem travel for valve having 65 cu in topwork.

Fig. 18 shows the measured response of the 132 positioner for valve stroke of ½" working into a valve having topwork volume of 65 cu in.

The transfer function under these load conditions is:

$$\frac{\text{input (0.5-5 ma)}}{\text{output (3-15 psi)}} = \frac{K}{(1/\omega_0)^2 S^2 + 2\,(\tau/\omega_0)\,S + 1}$$

where ω_0 is the natural frequency of the Microsen Balance in radians per second; F_0 is the natural frequency of the Microsen Balance in cycles per second $= \omega_0/2\pi = 0.8$ cps; S is the operator d/dt; τ (damping ratio) $= 0.3$; $K = 12$ psi/4.5 ma.

For other valve tops and valve strokes:

$$F_0 = (0.8 \text{ cps}) \sqrt{65/(\text{Load Volume})}$$

$$\tau = 0.3 \sqrt{\text{Load Volume}/65}$$

where load volume is in cubic inches.

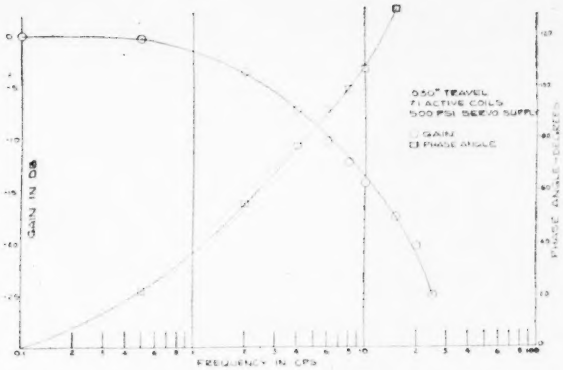


FIG. 16. RESPONSE of Hagan Model 600 driving a 5x10 hydramotor.

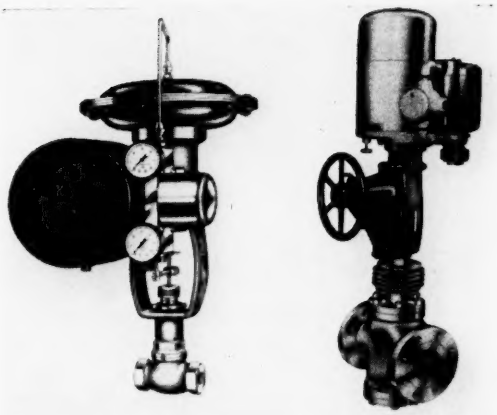


FIG. 17. MM&M American-Microsen Series 132 electropneumatic actuator (left) and Series 181 electrohydraulic actuator (right).

Series 181 Electrohydraulic Actuator

The American-Microsen Series 181 electrohydraulic valve operator (Fig. 17, right) is a power unit with position feedback to operate slip-stem valves for automatic process control. It positions the valve plug in accordance with the magnitude of a d-c signal. The operator mounts on standard yokes supplied with conventional diaphragm-operated control valves.

Three types of operators are available: the 1½" maximum-stroke normal-thrust model (for 1350 pounds force), the 4" maximum-stroke normal-thrust model (for 1350 pounds force), and the 4" maximum-stroke high-thrust model (for 3300 pounds force). All use 500-psi hydraulic pressure.

The Series 181 valve operator can be approximated as a first-order lag up to the break frequency of 0.7 cps:

$$\text{Output/Input} = K/(1 + TS)$$

where K is a dimensional constant involving ma input plus output stroke in inches, and T is time in seconds. Fig. 19 is the frequency-response plot obtained by test.

Performance specifications are:

	1½-181	4-181
Input signal	0.5 to 5.0 or 1.0 to 5.0 ma dc	Same
Stroke	½" to 1½"	½" to 4"
Max Thrust	1350 lbs	1350 or 3300 lbs
Stroking speed (no load)	0.4/sec	0.4"/sec or 0.2"/sec (high thrust)
Frequency Response	3 db attenuation at 0.7 cps with 90° phase lag, for ½" stroke	Same except high thrust model is down 3 db at 0.25 cps with 60° phase lag.

NEXT MONTH—This discussion of combination valve actuators will conclude with the Annin, General Controls, Mason-Neilan, Midwestern, Moog, and Swartwout actuators.

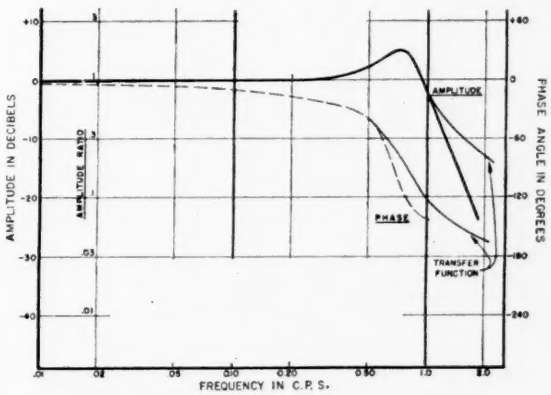


FIG. 18. RESPONSE of the type 132 at ½" valve stroke, working into a valve having topwork volume of 65 cu in.

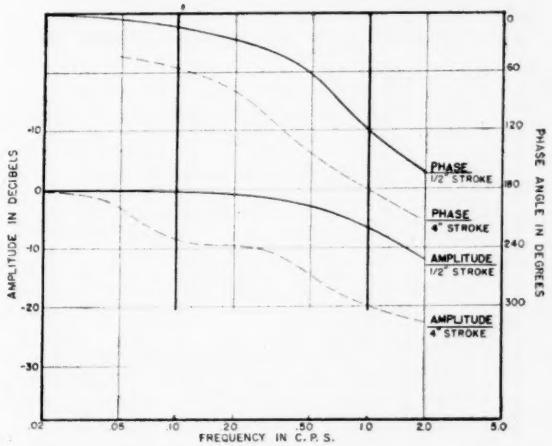
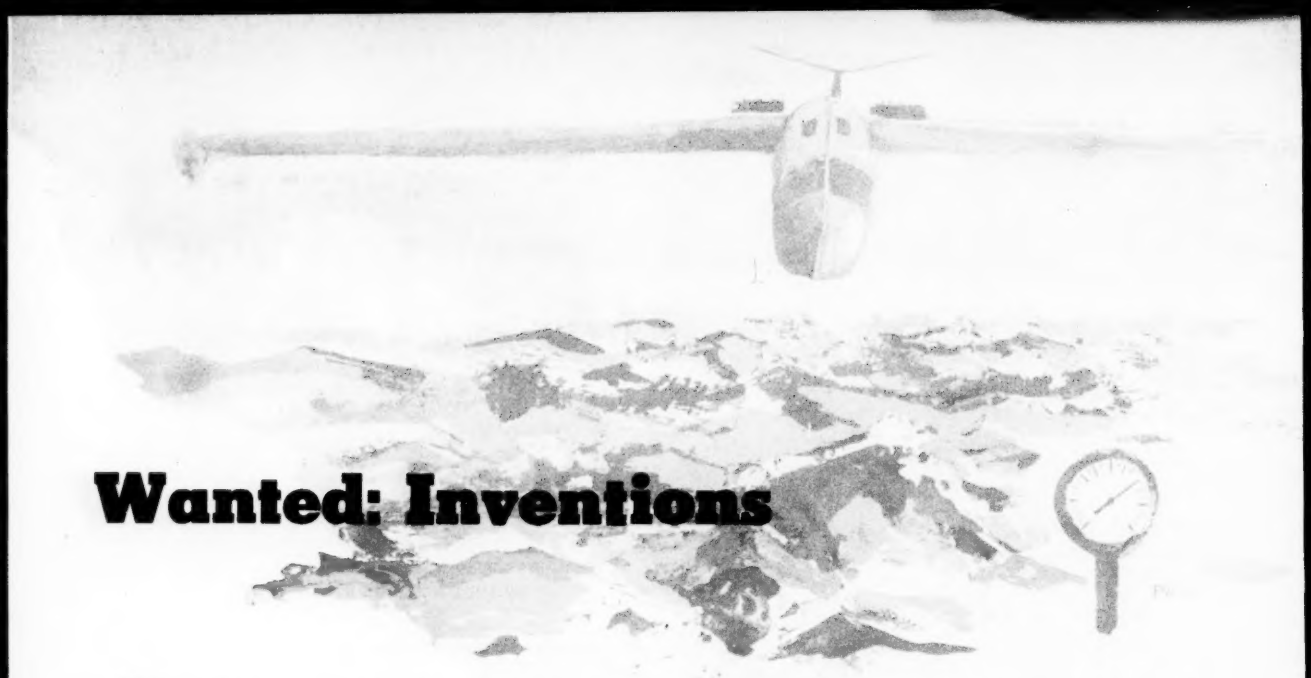


FIG. 19. RESPONSE of Series 181 electrohydraulic actuator for ½" and 4" strokes, ± 10% amplitude.



Wanted: Inventions

THIS list is selected from the booklet "Inventions Wanted by the Armed Forces" that catalogs hundreds of areas in which the government is actively seeking new ways of doing things. If you have specific solutions to these problems, or can suggest a probable course for further research, submit each proposal as a separate, typewritten document directly to: The National Inventors Council, U. S. Department of Commerce, Washington 25, D. C.

781. MEASURING TRANSIENT DEFLECTION OF PAVEMENT.—A method or instrument for measuring the transient deflection of pavement under wheels of slowly moving aircraft.

750. AIRBORNE WAVE HEIGHT INDICATOR.—A simple, dependable, lightweight device to measure and indicate the height of ocean waves to the pilot of a seaplane preparing to land.

748. NET AND GROSS THRUST MEASURE.—A device or satisfactory method for measuring net and gross thrust in flight.

738. PORTABLE LIQUID OXYGEN PURITY ANALYZER.—A small, portable, liquid oxygen purity analyzer to measure 97-100% pure oxygen and to detect various hydrocarbons in liquid oxygen of less than 100% purity.

698. VIBRATION LEVEL DETECTOR FOR HELICOPTERS.—A device which will measure and present a continuous recording of critical vibration levels to helicopter flight crew members. Terms of reference should be related to aircraft structural strength and human physical comfort.

665. INTERVAL TIMER.—A remotely-settable mechanical interval timer with 5- to 100-second range, 0.1% accuracy which meets USAF airborne specifications.

612. WIND MEASURING EQUIPMENT.—An instrument for the measurement of surface wind speed and direction where icing and high winds preclude normal operation of standard anemometers and wind vanes.

611. FATIGUE DAMAGE INDICATOR.—There is a requirement for an indicating device which will indicate impending failure in fatigue of propeller and rotor blades and components.

606. ABSOLUTE ALTITUDE DEVICE.—Development of an accurate means of determining absolute altitude above terrain which will not require prior knowledge of the terrain altitude (preferably nonradiating).

605. RANGE INDICATOR.—A range measuring device (preferably nonradiating) that can range 20,000 to 30,000 feet ahead of an aircraft flying at 500 to 1,000 feet absolute altitude.

604. VERTICAL SENSING ELEMENT OR INDICATOR.—A sensing element or indicator attached to an object, giving its true angle in the vertical plane and not being affected by the angular position of the object around any axis within ± 20 degrees in the vertical plane. Desired accuracy is 0.10 degree.

595. ODOR MEASURING DEVICES.—Scope—A practical means for the quantitative and qualitative analysis of odors.

592. AIRSPEED INSTRUMENTATION.—Instrumentation which will permit measurement of airspeed through means other than the sensing of static and dynamic pressures. The instrumentation should be capable of measuring supersonic speeds through Mach 3.0 to an accuracy of 1%.

578. HELICOPTER ATTITUDE INDICATOR.—A relatively simple, lightweight instrument that will indicate the correct attitude of the helicopter fuselage in the hover condition as well as in flight and which will indicate drift in any direction.

566. AMBIENT HUMIDITY MEASUREMENT.—One or more methods of measuring the relative (or

absolute) humidity of the atmosphere through which an aircraft is passing.

820. RADAR PERFORMANCE MEASUREMENT.—Device to indicate continuously the ability of a radar to detect a given target.

819. ELECTRONIC TIMER.—Device to indicate the time displacement of a video pulse to 0.01 microsecond. It should be similar to units now capable of resolving to 0.1 microsecond.

815. INTERVAL TIMER.—A low cost, lightweight, expendable interval timer with 0.010 to 0.050 second range, ±10% accuracy. The timer should provide 10 to 50 stations.

716. METEOROLOGICAL SOUNDING EQUIPMENT.—Equipment which will obtain soundings of the atmosphere (temperature, pressure and relative humidity to 100,000 feet or greater) without using airborne instruments such as radiosondes. The equipment is to be ground based and portable.

776. HEAT FLOW METER.—A sensitive heat flow meter which will not significantly disturb the heat flow to be measured in snow, ice or permafrost.

714. WINDS IN THE STRATOSPHERE.—A new technique for measuring the wind speed and direction in the region 100,000 to 400,000 feet. Equipment is to be carried aloft in a small sounding rocket.

594. SENSING AND MEASUREMENT OF ATMOSPHERE MOISTURE.—The major problem in hygrometry is the making of an absolute measurement of moisture (dew-point, frost-point, relative humidity, or absolute humidity). The range of atmospheric moisture is from 0.3 mg to 30 grams of water in a cubic meter of air or over a vapor pressure range of 0.0005 mb to 40 mb. The increments of measured moisture desired is in a dew-point temperature of 1°C, with an accuracy of 0.2°C, for atmospheric temperatures above freezing.

593. METHODS OF MEASURING AND INDICATING CLOUD LIQUID WATER CONTENT.—Means for measuring and indicating the liquid water content (LWC) of a cloud.

503. WEATHER OBSERVATIONAL APPARATUS.—An economical, automatic, accurate weather observational apparatus which will record weather elements (including humidity, wind speed, wind direction, etc.) and make a permanent record or broadcast weather conditions under extremely cold or hot conditions.

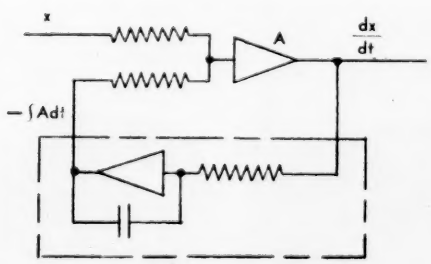
607. WIND VELOCITY INDICATOR.—A simple, reliable, non-radiating device to measure surface wind velocity (within 5 feet per second) and direction (10°) from an aircraft in flight.

450. DESTRUCTIVE RAY.—Equipment of usable size capable of producing destructive or death rays effective at 500 yards without excessive power input. Investigations to date indicate that tremendous amounts of power would be required using present techniques and that a completely new approach is indicated.

Derivative Via Integration

MAX FOGIEL

New York, N. Y.



$A = -\mu\,(x - \int A\,dt)$

if $\mu \to \infty$

$A/\mu \to 0$

$x \cong \int A\,dt$

$A \cong dx/dt$

IT often is necessary to obtain the derivative of a quantity represented by a voltage. The usual approach is to use a differentiating circuit, and to obtain the derivative by applying the required voltage to it. However, high-frequency noise arising from the amplifier circuit is emphasized by this differentiating process to the extent that it can completely mask the desired signal.

The circuit shown in Fig. 1 smooths out irregularities caused by high-frequency noise. By applying the output of the summing amplifier to the integrating network and feeding back the output of the latter to the input of the summing network, the desired derivative is obtained.

Thus, in order to equate the feedback to the input signal x, which is to be differentiated, the output of the summing amplifier will adjust itself to assume the value dx/dt. In this manner the derivative of a desired function is obtained with noise greatly diminished.

The action is shown under the illustration, assuming that the signal out of the amplifier is a voltage A.

Wheel And Belt Digital Readouts

Following the résumé of digital readouts in our June issue, here are the basic features of commercial wheel and belt readouts.

THE FOLLOWING descriptions of available mechanical counters illustrate the state of the art. Given for each type are principle, inputs, data display rate, and features.

Autron Engineering "Neuron" Counter-Wheel Visual and Switch-Readout Indicators

PRINCIPLE—Counter wheels driven by individual bi-directional stepping motors for adding and subtracting (Fig. 29-1).

INPUT—12, 24, 48 or 90 v dc or 110 v ac (±10%), or to specification (12 w up to 24 w required). Pulse should be square; minimum on-time and off-time are each 10 milliseconds.

DATA DISPLAY RATE—to 60 counts/sec.

FEATURES—Various combinations are available, such as 6-digit visual readout and 5-digit visual plus switch readout; manual or electric reset; electric switch contact readout standard on most models; choice of add-only, subtract-only or add-and-subtract models. Life is 300-million counts; 50-million counts for switch readout models.

Beckman-Helipot Digidial" Indicators

PRINCIPLE—Direct-reading counter couples directly to shaft, for manual setting or automatic readout of device to which attached (Fig. 29-2).

INPUT—Manually operated by capacitance insulated knob.

FEATURES—Ten-turn 3,600° continuous rotation; digital readings in full turns, tenths and hundredths; accuracy ±0.002 turn; nominal backlash 0.001 turn; white filled numerals on black face; positive friction lock; for ¼" shaft; easy indexing.

Borg Equipment Counter-Wheel Indicator

PRINCIPLE—Counter wheel has numbers representing degree rotation of shaft (Fig. 29-3).

INPUT—Shaft position, established manually (by knurled knob turning pot) or by motor.

FEATURES—Numerals are white on black, ⅛" wide by 3/16" high. Tenths digit is black on white. Readout is integral with shaft-driving knob. Available models have 3 digits for 10 turns, 4 digits for 100 turns, and 5 digits for 1000 turns. Inline digital presentation. Numbers viewed through sealed window. Units are completely sealed. Finger tip brake for 3-digit dial retains settings under vibration.

Bowmar Counter-Wheel Indicators

PRINCIPLE—Internal pinion counter wheels.

INPUT—Shaft driven.

DATA DISPLAY RATE—Above 600 rpm, equivalent to 6000 counts per minute.

FEATURES—Reversible and continuous operation. Low torque. Can be custom made to requirements.

Digitac Wheel-Type Counters

PRINCIPLE—Counter wheels driven by electrical solenoid (Fig. 29-5).

INPUT—Impulses.

DATA DISPLAY RATE—up to 40 counts per second.

FEATURES—Dynamically balanced incremental actuators. Five basic forms of presentation. Can add and subtract. Life is 10-million counts.

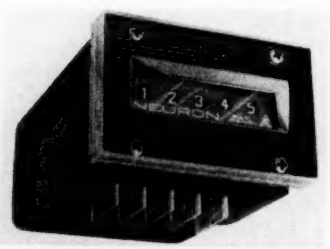


Fig. 29-1. "Neuron" counter features switch readout, rates to 40 per second and life of 300,000,000 counts.

Fig. 29-2. Helipot "Digidial" for 10-turn shaft-position indication.

Fig. 29-3. Borg "Microdial" for shaft position readout.

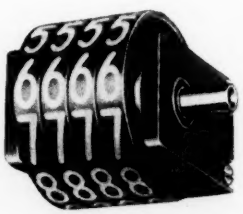


Fig. 29-4. Bowmar has no separating space or plates between wheels.

Fig. 29-5. Digitac counters.

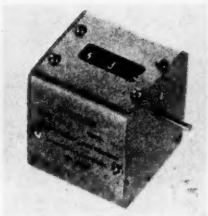


Fig. 29-6. "Digicon" and "Digidex" feature contacts.

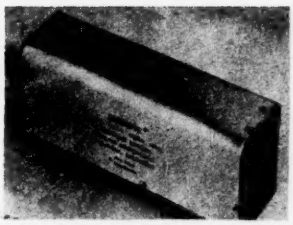


Fig. 29-7. Digitran "Digitote."

Fig. 29-8. Durant "Productimeter."

Digitran "Digicon," "Digidex," "Digitote" and "Digi-Tally"

PRINCIPLE—Numeric counter wheel with 10 electrical contacts opposite each number on each wheel, providing a single contact closure for each indicated digit (Fig. 29-6).

INPUT—Clockwise or counterclockwise shaft rotation from external actuators, motors, etc.

DATA DISPLAY RATE—Up to 20,000 counts per minute (2000 rpm slewing).

FEATURES—Digidex is same as Digicon except former has nonambiguous readout (closest contact is automatically selected by relay). Digitote totalizes pulses, has contact for predetermined control. Digi-Tally has stepping motor and contacts opposite each number on each wheel; can be provided also with shorting contacts and resistors wired across each contact to provide a voltage output proportional to number displayed.

Durant "Productimeters"

PRINCIPLE—Shaft-driven counter wheels (Fig. 29-8).

INPUT—Shaft rotation position; can be actuated by servomechanisms.

DATA DISPLAY RATE—up to 2500 rpm; 10 counts to one revolution of drive shaft, or 420 counts per second.

FEATURES—Numeral size is 3/16" x 9/64" and ¼" x 11/64", white figures on black background. Two- to seven-figure capacity.

Hycon Electronics Counter Units

PRINCIPLE—Mechanical counter assembly, Geneva driven (Fig. 29-9).

INPUT—Shaft driven. Also used with electric signal input as digital voltmeter.

DATA DISPLAY RATE—000 to 999 in less than 4 seconds; rotation up to 1500 rpm. When used as digital voltmeters, rate is thirty counts per second, average balance time for readout is 2 secs.

FEATURES—Numbers are 5/10" x ½"; life is more than 1000 hours of continuous operation; less than 0.25 inch-ounce to operate; weighs only 5½ ounces. Accessions include potentiometer assembly and servomotor assembly.

Landis & Gyr Sodeco Electrical Impulse Counters

PRINCIPLE—Counters operated by electric solenoid (Fig. 29-10).

INPUT—Voltages: 4-220 v dc; other models 24, 110 and 220 v ac.

DATA DISPLAY RATE—up to 25 counts/second.

FEATURES—Single-decade, 4, 5 or 6 digits. Nonresettable, manual or electric. Adding and/or subtracting. Preselection counters with manual reset or automatic re-cycling. Factory preset subtracting counters with contact operated at zero position. Periodical, armature operated auxiliary and reset contacts. Made in Switzerland.

Patwin "Magneline" Digital Readout

PRINCIPLE—Magnetically-actuated ball-bearing-type counter wheel (Fig. 29-11).

INPUT—Pulse of 0.028 ampere, actuated by varying an electro-magnetic field.

DATA DISPLAY RATE—0.5 second positioning.

FEATURES—⅝" x ⅜" digits are legible at 25 feet. Retains position without power. Only one moving part. Has been tested to 8 million readouts without failure.

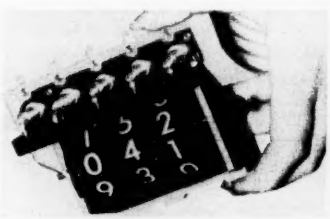


Fig. 29-9. Hycon counter unit.

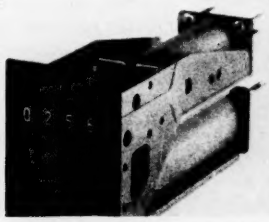


Fig. 29-10. Sodeco impulse counters are Swiss-made.

Fig. 29-11. Patwin "Magneline."

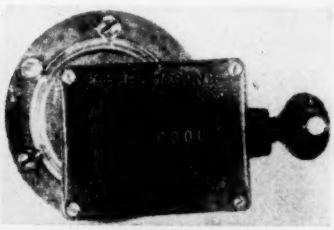


Fig. 29-12. Pneumaticount readout features hydraulic actuation.

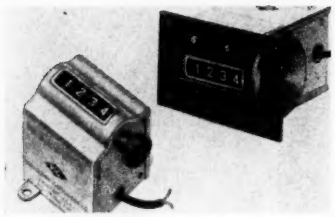


Fig. 29-13. PIC counters include "Mercury, Silver-King and Super Wizard."

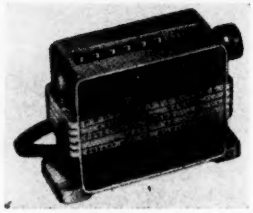


Fig. 29-14. Photoswitch counter.

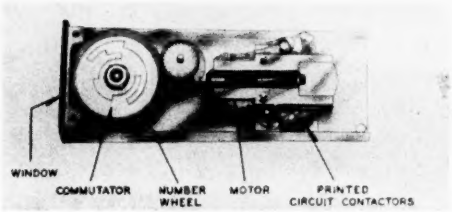


Fig. 29-15. US&S digital indicator has 4-bit coded input and integral motor.

Pneumaticount Hydraulic-Action Counter

PRINCIPLE—Counter wheel driven by changes in input fluid pressure, air or hydraulic (Fig. 29-12).

INPUT—Counter can be set so that hydraulic pressure of as low as 50 psi or as high as 10,000 psi will actuate wheel to count one unit.

DATA DISPLAY RATE—up to 300 counts/min.

PIC Counter-Wheel Indicators

PRINCIPLE—Counter wheel actuated by mechanical or electric pulse input (Fig. 29-13).

INPUT—Shaft rotation, lever stroke, or electrical signal of as little as 16 ma at 230 v.

DATA DISPLAY RATE—Up to 4000 counts per minute. Minimum duration of make on electric models is 0.024 second; minimum duration of break is 0.036 second.

FEATURES—Various models provide manual reset or electrical reset. Numerals are ¼" high; 4-, 5- and 6-digit models are available. Life is up to 200 million counts. Wheels and gears and accessories are available as components. Dozens and gross count is also available.

Photoswitch Counters

PRINCIPLE—Electric-signal-operated (pulses from photocell-amplifier combination) wheel-type counting unit (Fig. 29-14).

DATA DISPLAY RATE—Up to 600 counts/minute.

Union Switch & Signal Numeric and Alpha-Numeric Indicators

PRINCIPLE—Motor-driven 1-digit counter wheel (Fig. 29-15) or alpha-numeric belt. When input code does not match that of the internal commutator (with contacts on radially-coded wheel), motor is activated until commutator equates the input. 72 characters are on belt of alpha-numeric unit.

INPUT—Four-bit parallel binary code (each bit is brought in on a separate wire) at 26 v dc; six-bit code for alpha-numeric unit.

DATA DISPLAY RATE—0.8 second per numeric; 1.7 seconds for alpha-numeric.

FEATURES—Readout is stored electrically as well as visually and the stored numeral (electric signal) can be transmitted over control wires to other indicators or relays. Life is 10^6 random indications (numeric); 5 x 10^5 indications for alpha-numeric. Power required is 26 v dc for driving motor, approximately 3 watts (numeric), 7.5 watts (alpha-numeric). Lamp behind belt illuminates character.

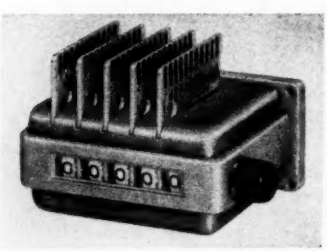


Fig. 29-16. Data readout counter of Veeder-Root creates specific contact closure for each digit indicated—5-digit unit provides 100,000 distinct circuit arrangements.

Veeder-Root Numeric and Alpha-numeric Counters

PRINCIPLE—Counter wheels, driven mechanically or electrically as required (Fig. 29-16).

INPUT—Rotary-shaft mechanical counter or electromagnetically actuated counter optional. Electromagnetic counters are available with a variety of operating voltages ac or dc.

DATA DISPLAY RATE—Mechanical counters can accept up to 5000 counts per minute of the right-hand wheel (500 rpm of the counter drive shaft). The electromagnetic counters can accept up to 1000 impulses per minute.

FEATURES—Many models and types, including "remote data readout" units with printed circuit commutator on each wheel. In this unit each counter with its 5-figure capacity provides 100,000 distinct circuit arrangements which lend themselves to exacting control and transmission requirements. These counters are available with manual and remote electrical reset as required. Power failure on the part of the readout circuitry will not cause loss of count as long as the counter receives either a manual or electrical impulse, which will advance it accordingly. Electromagnetically actuated counters can be wired simply.

Next in the Digital Automation Series

October: Survey of available display-type digital readouts.

November: Survey of tube-type readouts.

ELECTRONIC CIRCUITRY

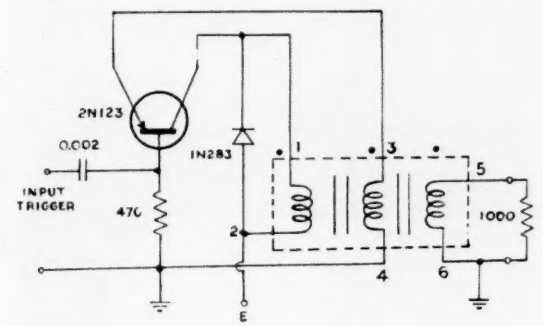
The circuit is the heart of all electronics. Here are 2 more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

CHARLES F. KEZER
and
MILTON H. ARONSON

TRANSISTOR BLOCKING OSCILLATOR

A 12-v 3-usec pulse is developed by this circuit, using a PNP type 2N123 transistor and a microminiature pulse transformer. Transformer (only 0.285" dia. x 0.35" long) is supplier's part number 94-758.

When the oscillator is at rest, collector current is at the small cutoff value because the emitter is returned to ground via transformer winding 3-4. When a negative trigger is applied to the input, base current flows. Collector current begins to flow in the direction to make collector potential less negative. Polarity of windings is such as to produce a positive voltage output at terminal 3, which is connected to the emitter. This produces increased emitter-to-base current, reinforcing the original trigger current, and regeneratively increases collector current.



Collector current quickly reaches saturation. After a time determined by transformer characteristics, emitter-to-base current begins to decrease. Collector current decreases, and regenerative action then rapidly shuts off current flow. Pulse output across the 1000-ohm load resistor is 12-v peak.

The 1N283 diode across winding 1-2 suppresses ringing or overshoot which might follow the pulse. Maximum repetition rate is 7 kc, corresponding to a maximum duty cycle of 0.02.

Pulse widths as short as 0.3 usec and up to 10 usec or longer may be obtained using other transformer and transistor combinations.

Input: Positive triggers, 2-v amplitude, 0.05-usec width, 0.02-usec rise time.

Output: Positive pulses, 12-v amplitude, 3-usec width, 0.1-usec maximum rise time. Fall time = 0.2-usec max.

Maximum duty cycle: 0.02.

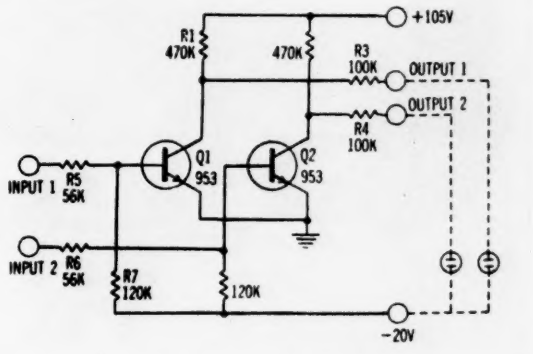
Power supply: —15 v d-c at 1.0 ma.

Source: Aladdin Electronics, Inc., 716 Murfreesboro Rd., Nashville 10, Tenn.

SILICON TRANSISTOR NEON DRIVERS

This circuit contains two independent (and identical) voltage amplifiers for driving NE-2 or NE-51 neon lamps from the outputs of transistor flip-flops. These lamps operate at 60-70 v and require a few volts higher for starting; transistor flip-flop outputs are typically levels of 6 and 16 v dc. Hence amplification by drivers (such as this circuit) is required. Circuit is available as plug-in module W112 from supplier.

Type TI-953 silicon NPN transistors are used in common-emitter circuits to drive neons. When input 1 is at 16-v dc, base of Q1 is positive with respect to its emitter, and saturation collector current flows. Collector potential is a fraction of a volt above ground, and the voltage applied to the neon is slightly over 20 v; the neon is extinguished. When the input voltage is shifted to 6 v dc, base voltage is —2.5 v, as determined by the divider R5-R7. As the base is negative with respect to the emitter,



collector current is cutoff, and nearly 125 v dc is applied to the neon lamp, more than enough to ignite it. Current in the neon is limited to a safe value by the drop in resistors R1 and R3.

Superior high-temperature characteristics of silicon transistors make possible operation in ambient temperatures to 100°C, compared to the customary limitation of 65°C for germanium types.

Inputs: D-c voltage levels as follows:
Lamp extinguished: 16 ± 3 v.
Lamp glowing: 6 ± 3 v.

Maximum load: Each channel, one NE-2 or NE-51 neon lamp.

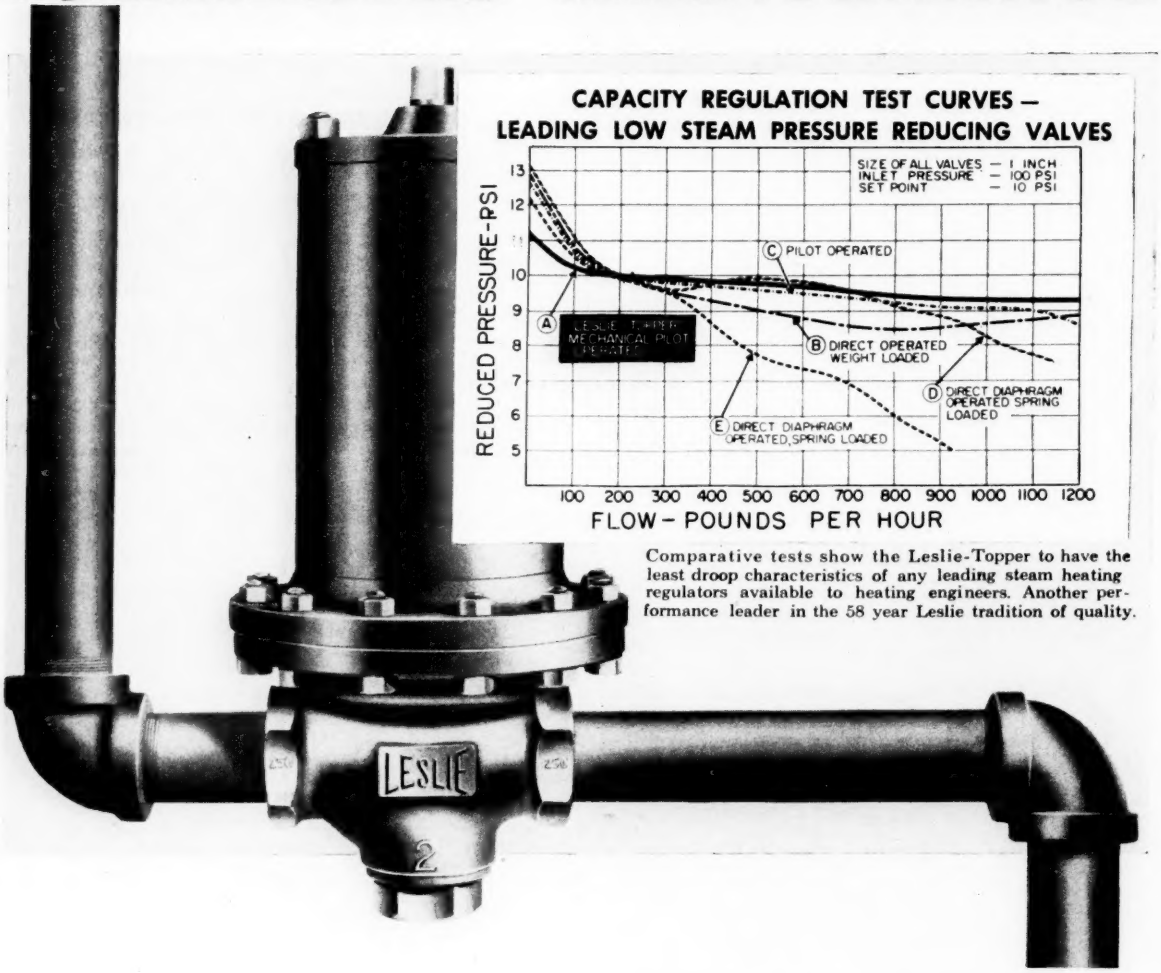
Ambient temperature range: —45° to 100°C.

Power supply: 105 v dc at 1.6 ma, —20 v dc at 0.8 ma. Voltage tolerance ±10%.

Source: Engineered Electronics Co., 506 E. First St., Santa Ana, Calif.

revolutionary pressure reducing valve with mechanical pilot out of steam path

ELIMINATES MAINTENANCE



Comparative tests show the Leslie-Topper to have the least droop characteristics of any leading steam heating regulators available to heating engineers. Another performance leader in the 58 year Leslie tradition of quality.

Now . . . a mechanical pilot operated reducing valve with direct operated simplicity and steam pilot accuracy . . . proven in comparative tests with other leading regulators a new concept in maintenance-free steam pressure reduction . . . the LESLIE-TOPPER

- Inlet pressures from 7 to 250 psi — reduced pressure ranges from 2 to 35 psi.
- Sizes ½", ¾", 1", 1¼", 1½", and 2".
- Piloting device entirely outside the path of steam.
- No dirt catching or close fitting parts — Use it for intermittent, continuous or standby service with complete confidence.
- Packless construction.
- Long life, long travel, *metal* diaphragm.
- Single-seated stainless steel main valve, hardened to 500 Brinell, seats on renewable *stellited* stainless steel seat ring for tight shutoff.
- No auxiliary operating air required.

All of this adds up to new reliability, freedom from maintenance and shutdown time. All of these extra quality features are available at less initial cost than any steam pilot or direct operated regulator you would endorse with your specification.

Eliminate your steam heat reducing valve problems this year, this heating season; write *now* for all the facts, including complete capacity-regulation data — or phone your Leslie representative. You'll find him listed in your classified directory.

TRADE LESLIE MARK

REGULATORS and CONTROLLERS

LESLIE CO., 299 Grant Avenue, Lyndhurst, New Jersey

For more information circle **58** on inquiry card.

Sizing of Conventional Relief and Safety Valves

L. P. STILLMAN
Manning, Maxwell & Moore Inc.

METHODS of sizing and selecting all safety and relief valves are basically the same, but vary somewhat in detail according to the valve application and the governing code.

Codes have been written by the A.S.M.E. to control the application of safety and relief valves in the interest of safety for equipment and personnel.

In addition, the A.S.M.E. has tested and approved performance characteristics and capacities of safety valves which have been submitted to them, and which have passed their requirements as stated in the specific code covering the application for which the valves are used. These capacities have then been certified by the National Board of Pressure Vessel Inspectors.

To date requirements have been set up only for testing and approving the conventional type and pilot-operated safety valve. Presently, pilot-operated valves are, for all practical purposes, confined to special applications because of the limitations of their design.

For the remaining types of valves on special applications the performance characteristics and capacities must still be a matter for agreement between the user and the safety and relief valve manufacturer.

The conventional-type safety and relief valve (comprising a valve body containing a nozzle or seating surface covered by a spring-loaded disc which opens automatically as the pressure increases above the "set pressure" of the valve) is the basic type of safety relief valve, and is the one which is used in the greatest majority of applications.

In addition to the conventional type, safety and relief valves are made in several other ways for specific applications. Some of these are (a) the bellows valve, with the bellows sealing the spring chamber and guiding surfaces from the fluid flowing through the valve, and allowing the valve to operate against some degree of variable back pressure, (b) the balanced disc and vented piston valve which allows the valve to discharge against some degree of variable back pressure, but also allows a constant escape to the atmosphere of any fluid in the discharge piping system if positive pressure exists at that point, and (c) the pilot-operated valve.

None of these special safety valves (which are not test approved in accordance with code requirements) or applications are discussed here. This chapter covers only conventional spring-loaded safety and relief valves.

The many different orifice sizes contained in a safety-relief valve line are identified by the manufacturer in two ways. One is the effective orifice area, and the other is by letter designation, as follows:

	sq inches
D	0.110
E	0.196
F	0.307
G	0.503
H	0.785
J	1.287
K	1.838
L	2.853
M	3.60
N	4.34
P	6.38
Q	11.05
R	16.00
T	26.00

These orifice areas are standard for all manufacturers, but the orifice letter designation has not been standardized in the larger size valves.

The sizing of safety and relief valves is a relatively simple procedure if the problem is approached in an orderly manner.

The steps involved are:

1. Determine the code, if any, that will govern the application of the safety or relief valves involved, and become thoroughly familiar with the requirements of this code. If the require-

TABLE 10-1—APPLICABLE CODES ACCORDING TO VALVE TYPE AND SERVICE

SERVICE	SAFETY RELIEF VALVE	SAFETY VALVE	RELIEF VALVE
Gas	ASME-UPV	-	-
Vapor	ASME-UPV	-	-
Liquids	ASME-UPV	-	ASME-UPV
Heating Boilers	-	ASME-LPHB*	-
Power Boiler Drums	-	ASME-PB*	-
Steam Superheaters	-	ASME-PB*	-
Steam Lines	ASME-UPV*	ASME-UPV*	-
Waste Heat Boilers	ASME-PB*	ASME-PB*	-
Air	ASME-UPV*	ASME-UPV*	-
Water	ASME-UPV	-	ASME-UPV
Oil	-	-	-
Corrosive Vapors	ASME-UPV	-	-
Corrosive Liquids	ASME-UPV	-	ASME-UPV
Compressor Discharge	ASME-UPV	ASME-UPV	-
Pump Discharge	ASME-UPV	-	ASME-UPV
Pressure Storage Tanks (Volatile Liquids)	ASME-UPV	-	-
L.P.G. Bulk Storage	NBFU	-	-
Gas Transmission and Distribution	ASA	-	-
Marine Service	-	USCG*	-

*These valves must have lifting levers. Plain levers are satisfactory.

NOTE: Lifting levers as noted above are required by Code. It is recommended, however, that all valves be installed with lifting levers. Plain levers are satisfactory for air, steam and water service. On other services, safety relief valves with packed lifting lever should be used.

CODE SYMBOLS

ASME-UPV — ASME Code, Unfired Pressure Vessels—Latest Revision.
ASME-PB — ASME Code, Power Boilers—Latest Revision.
ASME-LPHB — ASME Code, Low Pressure Heating Boilers—Latest Revision.
ASA — ASA B31.1.8—American Standard for Gas Transmission and Distribution Piping Systems—Latest Revision.
NBFU — National Board of Fire Underwriters Standards for the Storage and Handling of Liquefied Petroleum Gases—Latest Revision.
USCG — U. S. Coast Guard Marine Engineering Regulations for Boiler and Superheater Safety Valves—Subpart 52.65, Safety Valves.

ment involved is not subject to code regulation then the application of the safety or relief valve must be made on the basis of positive protection of the equipment under consideration.

2. Determine the set pressure at which the valve must open (or pop) and the flowing pressure at which the valve must relieve the volume of fluid injected into, or generated in, the system. Any constant back pressure involved must, of course, be considered and specified.
3. Determine the exact or approximate physical characteristics of the fluid which must be handled through the safety or relief valve.
4. Determine the safety or relief valve capacity required to adequately protect the equipment involved from dangerous overpressure, or to prevent the internal pressure from exceeding the vessel accumulation allowed by the governing code.
5. By formula or other means which will satisfy the code or other requirements, determine the required orifice area in (or valve size of) the safety or relief valve necessary to handle the required capacity under the existing conditions.
6. Select a valve or existing valve orifice which has an orifice area equal to or greater than the requirement determined in step 5.
7. At this point the valve materials such as bronze, iron or steel must be chosen to enable final selection of the safety or relief valve. This will involve consideration of (a) corrosion characteristics of the lading fluid, (b) relieving temperature and pressure, (c) strength required in the valve body and, frequently, (d) consideration of conditions that might exist in the area in which the valve is located.
8. At this point we are ready to select a valve. The valve selected must be one that fits all the above requirements of (a) orifice area or capacity, (b) pressure, (c) temperature, and (d) material requirements. Most manufacturers have selection charts which can be used to determine the applicable valve quickly and easily by plotting coordinates of pressure and temperature after the capacity or orifice area and valve materials are known.
9. Finally, the accessories and other specifications must be chosen and specified if desired.
   (a) Gag
   (b) Lifting Lever—plain, packed or air operated

The two codes and the scope of each involved in the sizing and selection of safety relief valves in the process industries are outlined below, and the methods used in sizing valves under the requirements of each are detailed therein. Table 10-1 is helpful for quick reference in determining the applicable code for the various services encountered.

State Codes

Most of the individual states either adopt directly, or enact regulations that are essentially the same as, the A.S.M.E. Codes. Therefore, we will consider only the basic codes, and suggest that the applicable state codes be consulted where they exist.

A.S.M.E. Power Boiler (P.B.) Code

This code regulates the sizing and selection of safety valves on all fired steam-boiler drums, unfired waste heat boiler drums, and (usually) the steam super-heaters, economizers and reheaters. (All off-boiler and process steam line valves are covered by the A.S.M.E.—Unfired Pressure Vessel Code).

This code also covers pressure vessels in which an organic fluid (such as dowtherm) is vaporized by the application of heat resulting from the combustion of fuel. Vessels, however, in which vapor is generated incidental to the operation of a chemical or petroleum processing system are not covered by the Power Boiler Code.

Sizing—P.B. Code—Steam

Under the Power Boiler Code, safety valves must be sized for 90% of their actual rated capacity and at 3% overpressure. Most manufacturers publish tables giving safety valve A.S.M.E.-rated (for the PB Code 90% of actual) capacities in pounds per hour of saturated steam at 3% overpressure.

These tables are arranged in such a way that the determination of the required orifice area or valve size is quite simple (Table 10-2).

When necessary, these orifice areas can be calculated by the formula:

$$W = (51.45)(APK)(0.90)$$

or

$$A_r = W_r/51.45\ (PK)\ (0.90)$$

where W = weight of stream per hour, pounds,
W_r = required weight of stream per hour, pounds,
P = (1.03) (set pressure) + 14.7 = absolute pressure, pounds per square inch,
K = average coefficient of discharge,
A = actual nozzle throat area, square inches,
A_r = required nozzle throat area, square inches.

When the steam passing through the safety valve is superheated a correction factor must be used. Tables of *superheat correction factors* are available.

Sizing—P.B. Code—Organic Fluids

Organic fluids are used as a heat transfer medium. The fluid is of uniform composition and physical characteristics and lends itself to sizing with tables. Safety-relief-valve manufacturers have such tables available, and they are used to size valves in exactly the same way as the steam capacity tables discussed previously.

A.S.M.E Unfired Pressure Vessel Code

The A.S.M.E.—Unfired Pressure Vessel Code is probably the most widely used code of this type in existence today because of the many applications it covers in so many different industries. It regulates the sizing and selection of all safety valves coming under its jurisdiction.

The code covers, in general, all unfired pressure vessels with inside diameters larger than 6" that contain pressures above 15 psig, except small heated hot-water-supply storage tanks with a water containing capacity of 120 gallons or less.

This covers practically all applications in the chemical, petroleum, petro-chemical and other general industrial services including the protection of process steam lines, process pipelines, pumps, turbines, compressors, and equipment subject to overpressuring due to the failure of pressure regulators.

The A.S.M.E.—Unfired Pressure Vessel Code does not cover fired steam boiler drums, unfired waste heat steam boiler drums, most steam superheaters, economizers or reheaters.

Helpful information outside of the code is contained in A.P.I. Tentative Standard RP-520 issued by the American Petroleum Institute (50 W. 50 St., New York 20, N. Y.), and the A.S.M.E. Power Test Code 25-1958 issued by the American Society of Mechanical Engineers (29 W. 39 St., New York 18, N. Y.).

Table 10-2. Capacity Table.

Capacity in Lbs. Per Hour of Saturated Steam at Set Pressure Plus 3% Overpressure.

Set Pressure Lbs. Sq. In. Gauge	ORIFICE DESIGNATION												
	D	E	F	G	H	J	K	L	M	N	P	Q	R
10	193	281	346	566	883	1448	2068	3910	4050	4883	7137		
20	175	319	487	799	1247	2045	2990	4539	5719	6894	10138		
30	295	408	630	1032	1611	2641	3779	5854	7381	8900	13087		
40	377	493	779	1265	1975	3237	4604	7177	9044	10906	16036		
50	327	584	915	1498	2339	3834	5475	8496	10708	12912	18984		
60	379	675	1057	1739	2715	4450	6356	9862	12429	14988	22037		
70	429	760	1199	1964	3067	5026	7178	11138	14039	16929	24890		
80	481	856	1350	2212	3454	5660	8084	12545	15812	19065	28032		
90	531	947	1494	2448	3823	6264	8947	13884	17500	21102	31030		
100	581												
110													

Sizing—U.P.V. Code

Valves which are installed under the Unfired Pressure Vessel Code should maintain a greater differential between the normal operating pressure in the protected system and the set pressure of the safety relief valve than is necessary in a power boiler. This is because of (1) the greater fluctuation in operating pressures, (2) the great variety of fluids which must be handled through the safety relief valve, and (3) the tendency of the lading fluid to carry foreign particles which will keep a safety relief valve from closing tightly. In no instance should the normal operating pressure exceed 90% of the valve set pressure. Any greater percentage will normally result in (1) valve leakage or "popping" under conditions of minor upset of the processing system as well as (2) serious increasing of maintenance expense.

In the case of low operating pressures an even greater pressure differential is required. A good rule which is widely used is to maintain a pressure differential between the normal operating pressure and the valve set pressure of 15 psi or more up to a set pressure of 150 psig, and limit the normal operating pressure to 90% of the safety valve set pressures above 150 psig.

In applications where pulsations are encountered the differential between the normal operating pressure and the safety valve set pressure should be even greater.

On pulsating installations (such as reciprocating pump or compressor service) the normal operating pressure should not exceed 80 to 85% of the set pressure of the safety relief valve depending upon whether the reciprocating unit is a simplex or multiplex type. In the simplex type it is best to hold the operating pressures to 80% of the set pressure while in the multiplex type it is usually satisfactory to operate the unit at 85% of the valve set pressure. The maximum differential possible should be used on all installations with a minimum of 15 psi on all set pressures under 150 psig.

In some cases where several single or multi stage compressors discharge into the same header there is the possibility of two or more of these compressors operating at times "in phase." Under these conditions considerably higher differential pressures are sometimes required in order to keep the safety or relief valve disc from lifting with each pulsation wave. This condition, however, must usually be determined and corrected after the system is placed in operation.

In considering the sizing of safety valves under the Unfired Pressure Vessel Code we will discuss safety valves on vapor service and relief valves on

liquid services separately as the allowable overpressures (pressure above the set pressure at which the valve is permitted to flow) vary with different applications.

While the A.S.M.E.-Unfired Pressure Vessel Code states that "all unfired pressure vessels other than unfired steam boilers shall be protected by pressure-relieving devices that will prevent the pressure from rising more than 10% above the maximum allowable working pressure (except "when the excess pressure is caused by exposure to fire or other unexpected source of heat") it does not cover all of the liquid service units requiring protection in the process equipment. For this reason some of the liquid relief valves are sized with as much as 50% overpressure.

Most relief valve capacities are rated at 25% overpressure even though they must be sized at 10% overpressure when protecting code vessels or systems including code vessels. Corrections must be made because of the lower overpressure in such cases.

One code deviation from the requirement limiting accumulation on the vessel to 10% above the maximum allowable working pressure of the vessel, reads as follows: "Where an additional hazard can be created by exposure of a pressure vessel to fire or other unexpected sources of external heat (for example, vessels used to store liquefied flammable gases), supplemental pressure-relieving devices shall be installed to protect against excessive pressure. Such supplemental pressure-relieving devices shall be capable of preventing the pressure from rising more than 20% above the maximum allowable working pressure of the vessel". A single safety valve may be used providing it satisfies both this requirement and the one which limits the accumulation to 10% above the maximum allowable working pressure of the vessel.

The graph shown in Fig. 10-1 will be helpful in understanding these relationships as they apply to the accumulation on the vessel and the overpressure on the safety or relief valve.

Most manufacturers have published information covering methods of sizing safety and relief valves under the requirements of the Unfired Pressure Vessel Code. Most of these, however, are based on tested procedures and calculations set forth in the code.

Sizing—U.P.V. Code—Vapors and Gases

As in the case of Power Boiler Code valves, manufacturers publish tables for sizing safety valves under the Unfired Pressure Vessel Code for common gases and vapors such as saturated steam and air.

These tables, however, are based on flowing conditions at 10% overpressure and (instead of the 90% of actual capacity required in the Power Boiler Code) are allowed 100% of the rated capacity—providing they have been tested under the Unfired Pressure Vessel Code regulations.

In sizing the safety valve, the tables are used in the same way as the tables in the Power Boiler Code even to the application of the superheated steam correction factor necessary when sizing safety valves for superheated steam service.

However, when sizing valves for other vapors or gases, or mixtures composed of pure gases of varying molecular weights, the problem becomes slightly more complex and a formula must be used.

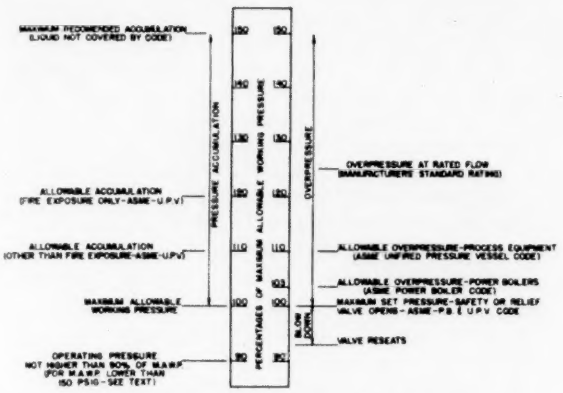

MAXIMUM RECOMMENDED ACCUMULATION (LIQUID NOT COVERED BY CODE)
ALLOWABLE ACCUMULATION (FIRE EXPOSURE ONLY-ASME-U.P.V.)
ALLOWABLE ACCUMULATION (OTHER THAN FIRE EXPOSURE-ASME-U.P.V.)
MAXIMUM ALLOWABLE WORKING PRESSURE
OPERATING PRESSURE NOT HIGHER THAN 90% OF M.A.W.P. (FOR M.A.W.P. LOWER THAN 150 PSIG-SEE TEXT)
PRESSURE ACCUMULATION
PERCENTAGES OF MAXIMUM ALLOWABLE WORKING PRESSURE
OVERPRESSURE
OVERPRESSURE AT RATED FLOW (MANUFACTURERS' STANDARD RATING)
ALLOWABLE OVERPRESSURE-PROCESS EQUIPMENT (ASME UNFIRED PRESSURE VESSEL CODE)
ALLOWABLE OVERPRESSURE-POWER BOILERS (ASME POWER BOILER CODE)
MAXIMUM SET PRESSURE-SAFETY OR RELIEF VALVE OPENS-ASME-P.B. & U.P.V. CODE
BLOW DOWN
VALVE RESEATS
150
140
130
120
110
103
100
90
80

Fig. 10-1. Pressure relations in safety and relief valves.

The basic formulae used to obtain the required orifice area allow extreme flexibility in that valves can be sized accurately for almost any service condition of gas or vapor mixture (or weight), gas or vapor capacity, temperature, ratio of specific heats, compressibility factor or flow coefficient:

FOR STEAM WITH CONSTANT BACK PRESSURE LESS THAN 58% OF SET PRESSURE:

$$W_s = 51.5\ KAP$$

$$\text{or}\quad A_r = \frac{W_{sr}}{51.5\ KP}$$

FOR ANY GAS OR VAPOR WITH CONSTANT BACK PRESSURE LESS THAN 55% OF SET PRESSURE:

$$W = CKAP\sqrt{M/ZT}$$

$$A_r = (W_r/CKP)(\sqrt{ZT/M})$$

where W_s = actual capacity, pounds of steam per hour,
W_{sr} = required capacity, pounds of steam per hour,
W = actual capacity, pounds of any gas or vapor per hour,
W_r = required capacity, pounds of any gas or vapor per hour
C = constant (for gas or vapor) which is a function of the ratio of specific heats, C_p/C_v or k (available from tables). If the ratio of specific heats, k, (C_p/C_v) is not known, use $C = 315$, which is the value of C when $k = 1$.
K = coefficient of discharge or flow coefficient for most safety valves = 97.5% (manufacturers literature should be consulted)
A = actual orifice area of the safety valve, square inches,
A_r = required orifice area of the safety valve, square inches,
P_1 = flowing pressure in pounds per square inch absolute = set pressure plus overpressure plus 14.7
M = average molecular weight of gas or vapor,
T = absolute temperature at inlet (degrees Fahrenheit plus 460)
Z = compressibility factor corresponding to P_1 and T. (If not available, compressibility correction can be safely ignored. Use value $Z = 1.0$).

When constant (not variable) back pressure exists at the valve outlet, and this absolute pressure exceeds 55% of the absolute flowing pressure (set pressure

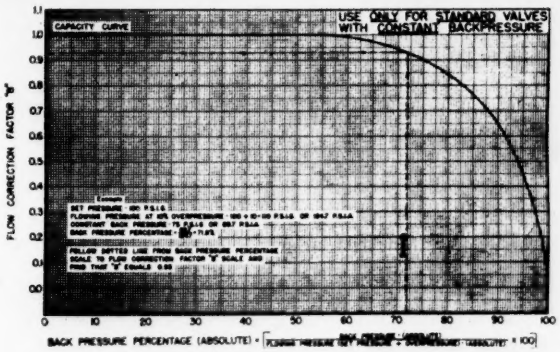

USE ONLY FOR STANDARD VALVES WITH CONSTANT BACKPRESSURE
CAPACITY CURVE
FLOW CORRECTION FACTOR "B"
BACK PRESSURE PERCENTAGE (ABSOLUTE)

Fig. 10-2. Flow correction factor for high but constant back-pressure.

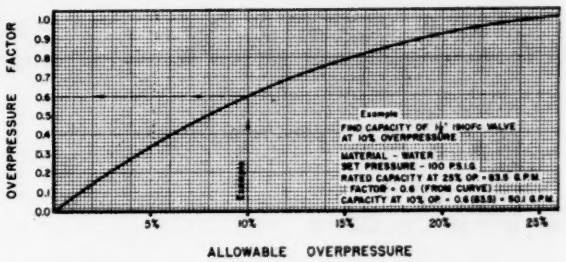


Fig. 10-3. Overpressure sizing factor for liquid safety-relief valves.

plus overpressure plus 14.7), a correction factor must be used to determine the valve capacity or orifice area. To determine the required orifice area A_r, divide the area found above by the flow correction factor "B" determined in Fig. 10-2, changing the formula to:

$$A_r = (W_r/CKPB)\sqrt{ZT/M}$$

The Unfired Pressure Vessel Code requires that rated capacities be marked on each valve. These capacities are in pounds of saturated steam per hour, or cubic feet of air (60° F. and 14.7 psia) per minute. Appendix J in the A.S.M.E.-U.P.V. Code gives a method of converting these capacity markings into terms of any other gas or vapor.

Sizing—U.P.V. Code—Liquids

Relief valves under the Unfired Pressure Vessel Code must also be marked to show capacities in pounds of saturated steam per hour, or cubic feet of air (60° F. and 14.7 psia) per minute. In addition, they can be marked to show capacity in gallons of water per minute at 70° F., or other fluids under standard conditions if desired.

There is, however, no required procedure set up to rate liquid valves in the U.P.V. Code so most of the manufacturers have standardized on a method of sizing these valves by formula. The formula at 25% overpressure is:

$$GPM = \frac{27.2\ A\sqrt{P}}{\sqrt{sp.gr.}}$$

$$A_r = \frac{GPM_r\sqrt{sp.gr.}}{27.2\sqrt{P}}$$

Where GPM = actual liquid capacity in GPM of the liquid involved at 70°F. and 25% overpressure,

GPM_r = required liquid capacity in GPM of the liquid involved at 70°F. and 25% overpressure,

A = actual orifice area of the safety valve, square inches,

A_r = required orifice area of the safety valve, square inches,

P = differential set pressure in pounds per square inch, (set pressure, psig, minus back pressure, psig)

sp.gr. = specific gravity (water = 1) of liquid at actual discharge temperature. (Note that the use of a sp.gr. at a lower than actual temperature will result in a safe valve size if the sp.gr. at actual flowing temperature is not available).

The above formula can be used only for sizing liquid-safety-relief valves at 25% overpressure. At other overpressures a sizing factor must be used. Overpressure sizing factors are obtainable from the curve shown in Fig. 10-3 for overpressures other than 25%. Fig. 10-3 also gives directions for using the curve.

Viscosity of the lading fluid, when high, must also be considered when sizing liquid-relief valves. The first step is to determine if the viscosity is sufficiently high to affect the sizing. This is a function of quantity of flow and orifice size, so first determine the actual orifice area of the valve, ignoring the possible effect of viscosity. If the viscosity at the operating temperature in Saybolt seconds universal is greater than that determined by the use of available curves, a correction for viscosity must be made.

Using the required liquid capacity, the actual orifice area and the viscosity at the flowing temperature, enter the proper viscosity correction chart and determine the correction factor for this orifice. Resize the valve using the viscosity correction factor "U_f" in the denominator as follows:

$$A_r = \frac{GPM_r\sqrt{sp.gr.}}{27.2\ U_f\sqrt{P}}$$

If the resized orifice is larger than the actual orifice area found originally then the calculation should be repeated, obtaining and using a new viscosity correction factor based on the larger orifice. Repeat this procedure until the valve is sized correctly when using the correction factor applying to the actual orifice area used in that calculation.

Checking Sizes—A.S.M.E.—P.B. and U.P.V. Codes

It is a well known fact that errors are sometimes repetitive when calculations are checked by the person doing the original job if the same method is used. On the other hand, it is sometimes a slow, expensive process for a different person to become familiar with all of the aspects of the problem.

For this reason safety and relief valve manufacturers have provided alternate methods of sizing these valves to enable the individual to check his own calculations.

Under the Power Boiler Code it is desirable to size by formula and check the sizing by the use of the table provided, although the procedure can be reversed if for some reason that course is preferred.

TELETAX* TELEMETERING

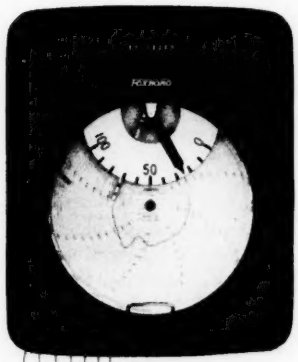
by Foxboro...

engineered for the most advanced transmission techniques

Telemetering matched in performance with famous Foxboro instruments — that's the Foxboro Teletax Telemetering System.

Through use of impulse-duration signals, Teletax electrically transmits measurements of a remotely-located variable to the central control station. Here, the Teletax receiver records the duration of impulse, which is directly proportional to the measured variable.

The Foxboro Teletax System is noted for its simplicity, its versatility, and its high sustained accuracy. For a transmission medium, it can use either AC or DC, an audio frequency carried on a transmission line, or radio or microwave impulses. Sustained accuracy is 0.5% of full scale.



TELETAX RECEIVERS

Teletax receivers include: Single or Dual Receivers; Multi-Record Receivers for recording up to 6 separate measurements on one chart; and Teletax Receiver-Controllers for automatic operation. And the Teletax signal can be simply converted to digital information.

For more information circle **146** on inquiry card.

TRANSMISSION LINK

With Foxboro's Teletax Telemetering System, you can use the most advanced transmitting techniques: two wire lines, power lines, radio or microwave. As many as 25 different signals can be handled in each direction, simultaneously.

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The Teletax Transmitter houses either one or two standard Foxboro measuring elements — plus the Teletax transmitting mechanism. It will transmit to a control center hundreds of miles away just as easily as to one nearby. It also indicates or records locally if desired.

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The Teletax Transmitter needs *no* periodic maintenance whatever, while the receiver requires only occasional oiling. And the receiver has a minimum of mechanical components to wear — no clutch to slip or jam.

Foxboro Teletax Systems are now in wide use on natural gas systems, water works, oil fields, power plants, steel mills, etc. Write for Bulletin 17-11C — it gives all the details. **The Foxboro Company, 469 Neponset Avenue, Foxboro, Mass.**

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TELETAX TELEMETERING

Journal of the S C M A . . .

SOUTHERN CALIFORNIA METER ASSOCIATION

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Computation of Orifice-Meter Gas Coefficients

Here are the factors used in calculating an orifice-meter gas coefficient, and a standard procedure for coefficient calculation by using these factors in a standard sequence.

W. J. KENNEDY
Southern California Gas Co.

PRIOR TO 1935, when Bulletin TS-353 *Tentative Standard Procedure for the Measurement of Natural Gas with Orifice Meters* was introduced, there were few standard methods of measurement procedure. It was common for each oil and gas company in the same area to have its own procedure. TS-353 provided a standard procedure.

Later, in 1941, Bulletin TS-402 *Tentative Standard Procedure for the Determination of the Corrected Hourly Gas Coefficient (C') Used in the Measurement of Natural Gas by Orifice Meters* was issued. This enabled the gas and oil companies to calculate coefficients on a standard basis, and, with the same gas flow data, a coefficient could be calculated in any area of California and identical results obtained.

In 1956 these bulletins were combined and published as Bulletin TS-561 *Tentative Standard Procedure for the Measurement of Natural Gas with Orifice Meters*. This bulletin was expanded to provide data for meter runs up to 30", and superexpansibility factors to 500 psi. TS-461, *Tentative Standard Procedure for the Determination of Superexpansibility and Manometer Factors used in Measurement of Natural Gas by Orifice Meters*, provides for the superexpansibility factors for pressures above 500 psi*.

It should be noted that the factor tables in the bulletins are in the same order as the factor arrangement in the coefficient formula. To expedite coefficient calculation it is best to use a coefficient record form (Fig. 1) which is designed to be used in the same order.

Basic Flow Formula

The Basic Flow formula is:

$$Q = C' \sqrt{hP_2}$$

where Q is quantity rate of flow in standard cubic feet per hour (at 14.73 psia and 60° F); h is differential pressure in inches of water across the orifice plate; P_2 is pressure in psia of flowing gas taken from downstream tap.

When using square-root charts the formula becomes:

$$Q = C' \times h_s \times P_{s2}$$

where h_s is differential pressure reading and P_{s2} is static pressure. Note: C' in this instance contains the square-root chart factor "M".

Coefficient Definition

The gas coefficient is the quantity of gas that will pass through a given sized orifice in a given sized orifice-meter run when the square-root readings of the differential pressure (h_s) and static pressure (P_{s2}) are unity.

Corrected Gas Coefficient

C', the corrected gas coefficient, is the product of the following factors:

$$C' = C \times M \text{ (or MI)} \times F_{e2} \times F_R \times F_{PV} \times F_G \times F_T$$

where C is the Basic Coefficient at 60° F and 14.73 psia base. This depends on the internal diameter of the meter run, the size of the orifice, and the location of the taps.

M is the square-root chart factor. This is the correction for the range of differential gauge when using square-root charts. The base 100 psi/100" = 1.000. The equation for $M = 0.01 \sqrt{R_h R_p}$

I is the Rockwell intergrator machine factor, used

*Bulletins TS-461 and TS-561 are published by the *California Natural Gasoline Association*, 510 W. 6 St., Los Angeles 14, Calif.

Presented at S.C.M.A. Short Course, January, 1958

October Meeting: Thursday, the 16th Rio Hondo Country Club, Downey, California.
Feature: Mr. Stanford B. Spracklen, of Beckman Instruments, Inc, will discuss Gas Chromatography and Process Control.

SOUTHERN CALIFORNIA GAS CO.—L.

METER NO. 1000 REMARKS

SIZE 4" CONNECTIONS Flange CLOCK 72 Hour

SOURCE OF GRAVITY: W.L.A. Sta. SOURCE OF TEMPERATURE: Meter #1000

COEFFICIENT RECORD

DATE EFFECTIVE	h_s / P_{s2}	h/P_2 / BETA	EXT. GROUP / S GROUP	LINE & ORIFICE / C	GAUGE RANGE OR (MI) / C_1 (MI) / F_{e2} F_R	C_1 (MI) x (F_{e2} F_R)	GAUGE PRESS / F_{PV}	C_1 (MI) x (F_{e2} F_R) F_{PV}	SP. GR. / F_G	TEMP. / F_T	C'	COMP	CK.
	6.0	0.4	7	4 x 2.500	100 #/50"	1316.0	40		.631	65			
1-30-58	7.40	.62	(3)	1387.2	0.9487	1.004	1321.3	1.004	1326.6	1.255	1664.9	K	C

FIG. 1. DETERMINATION of C' using TS-561.

when charts are read on the integrator. The base (I = 1.00) is 500 psi/100".

F_{e2} Expansion Factor

Unlike liquids, when a gas flows through an orifice the change in velocity and pressure is accompanied by a change in density. This expansion is taken care or by the *expansion factor*, which is a function of the differential pressure, the absolute pressure, the diameter of the pipe, the diameter of the orifice, and type of taps.

F_R Reynolds Number Factor

This factor depends on the viscosity, density, and velocity of the gas, and pipe diameter.

F_{PV} Superexpansibility Factor

This factor is used to correct for the fact that gases do not follow the ideal gas laws. It varies with the temperature and pressure, and with the type of gas.

F_G Specific Gravity Factor

This factor is used to correct for changes in specific gravity. With a given force, a larger quantity of lightweight gas can be pushed through an orifice than a heavier gas. This flow varies according to the square-root law—that is, twice as much gas having a specific gravity of 0.25 will flow through an orifice as will a gas having a specific gravity of 1.0. Thus:

$$F_G = \sqrt{1/\text{Sp Gr}}$$

F_T Flowing Temperature Factor

This factor corrects for changes of flowing gas temperature from the base of 60° F. A higher gas temperature means a lighter gas and greater flow, which must be corrected back to that at 60° F by use of the factor F_T:

$$F_T = \sqrt{\frac{460 + 60}{460 + \text{Flowing Temp.}}}$$

Sample Problem and Factors

Segments of the appropriate factor tables from TS-561 and coefficient record cards (Figs. 1 and 2) will be shown in the recommended sequence to compute the following problem.

1. Meter size is 4"; internal diameter is 4.026".

2. Flange connections are 1" above and 1" below the orifice plate.

3. Chart rotation is once every 72 hours.

4. h_s, square root differential reading, is 6.0. This value is obtained by averaging the differential readings of several charts prior to the date of the coefficient change. The h_s values are read to the nearest whole number and averaged to the nearest tenth.

5. P_{s2}, square-root static reading, is 7.40. This value is obtained by averaging the static readings of several charts prior to the date of the coefficient change. The P_{s2} values are read to the nearest tenth and averaged to the nearest hundredth.

6. Line and orifice is 4" x 2.500". The B, termed "beta," is the ratio of the diameter of the orifice to the diameter of the meter run (d/D). When using flange-connected meters, the best measurement is attained with orifice plates having ratios between 0.15 and 0.70.

7. C is 1387.2. (The basic coefficient for 4" x 2.500" orifice, from TS-561, Table 321)

8. Gauge range is 100 psi/50". M, the square-root chart factor is 0.7071 (Table 303).

9. Chart reading methods = Rockwell integrator 72-hour combined MI Factor.

$$I = \sqrt{(100/500)\,(100/100)} = 0.4472$$

This is the integration factor for square-root charts. Thus: MI (72 hrs) = 0.07071 x 0.4472 x 3 = 0.9487.

10. F_{e2}, the expansion factor, is a function of: h_s (6.0), P_{s2} (7.40) and beta (0.62).

11. F_R, Reynolds number factor, also is a function of h_s, P_{s2} and beta. The combined factor from Table 330 (F_{e2} F_R) = 1.004.

12. F_{PV}, superexpansibility factor, is a function of static pressure, specific gravity and temperature of the gas;

$P_{s2} - 7.40 = 40$ psig
Sp Gr = 0.631
Flow temperature = 65°F
F_{PV} = 1.004 (from Tables 331 and 335).

13. F_G, specific gravity, is 0.631. This is one of the most variable of the factors used. It corrects for the specific gravity variation of the gas.

14. F_T, flowing gas temperature = 65°F. This factor corrects for the temperature change in the flowing gas. The combined factors of F_G and F_T = 1.255 (from Table 342).

SOUTHERN CALIFORNIA GAS CO.-T-L

METER NO. 3001-1 REMARKS:

SIZE 16" CONNECTIONS Flange CLOCK 24 Hr.

SOURCE OF GRAVITY	SOURCE OF TEMPERATURE
3001-1	3001-1

COEFFICIENT RECORD

DATE EFFECTIVE	h_w P_{S2}	h/P_S BETA	EXT. GROUP S GROUP	LINE & ORIFICE C	GAUGE RANGE (MI)	C x (M) (MI) F_m	C x (MI) x F_m	GAUGE PRESS F_{PV}	C x (M) (MI) x F_{PV} F_m	SP. GR. F_G	TEMP. F_T	C'	COMP.	CK.
	-	-	-	16x10.500	1000/100	35943.		730	(N_2=3.2%)	.635	62			
1-30-58	-	-	-	25416.	1.4142	.999	35907.	1065	38241.	1.252		47878.	W	R

FIG. 2. DETERMINATION of C' using TS-461.

The product of the factors is established and entered in Fig. 1.

$$C \times (MI) \times (F_{s2}\, F_R) \times F_{PV} \times (F_G\, F_T) = C'$$
$$1387.2 \times 0.9487 \times 1.004 \times 1.004 \times 1.255 = 1664.9$$

Specific Gravity and Temperature Determinations

Specific gravity and flowing temperature are the most variable values. These values are determined by the following methods:

Specific Gravity

1. A recording gravitometer piped directly to the meter run provides a continuous record.
2. Gas Sample Tanks
   a. Accumulative sample wherein gas enters the tank only when there is flow through the meter. Usually this is a weekly gas sample.
   b. Continuous sample wherein gas enters the tank continuously. Usually this is a weekly gas sample.
   c. Spot sample where an operator fills the tank manually.
3. Portable specific-gravity instruments for spot tests of gas made in the field.
4. Source sample, used by several meters measuring the same quality gas.

In all gas sampling, great care is taken to insure a good sample by adequate purging of the sample tanks.

Temperature of Flowing Gas

1. Recording temperature gages on the meter.
2. Temporary recording gage on the meter.
3. Meters with same temperature characteristic using a base temperature location.
4. Ground temperature.
5. Spot temperature with stem thermometer.

The recorded temperature value is interpreted in the light of the following considerations: (1) Flowing temperature only should be used; (2) a large volume usually does not show atmospheric influence; (3) a small volume is influenced by atmospheric conditions; (4) after regulators the gas is cooled by expansion; and (5) after compressors the gas is heated by compression.

Significant Figures

When computing orifice coefficients, carry all computations to *five significant figures*. Use the number of significant figures given in the Tables in all cases. To determine the last significant figure in any computation carry all calculations to one place beyond the number of significant figures desired. When the next figure beyond the desired significant figure is 5 or more, add one to the last significant figure.

Subsequent Changes of Coefficients

Some coefficients are changed on a regular weekly basis and others on a monthly basis depending on the volume of gas measured through the meter. Note: These subsequent changes are the procedure of the Southern California Gas Company. Such procedures may vary in accordance with the standard practices of each company.

The coefficients will change whenever the values of the factors change to the following extent (provided the orifice plate has not been changed).

1. h_w—more than two units (example: from 4.0 to 7.0).
2. P_{S2}—more than one unit (example: from 6.0 to 8.0).
3. Specific gravity—more than 0.005 (example: 0.630 to 0.630).
4. Average Temperature—more than 4°F (example: 65° to 70°F).

Calculation of (C) for Non-Standard Internal-Diameter Meter Run

When the internal diameter of the meter run varies from the standard diameter used in the (C) tables by the percent allowable in Table XII, page 71, TS-561, the value of (C) should be calculated by the formula $C = d^2ZL$ using the "L" and "Z" Tables 803 and 804, pages 88 and 89, of TS-561.

For example, calculate (C) for a 6" (5.955" internal diameter) x 3.500" orifice:

$$B \text{ (beta)} = 3.500/5.955 = 0.588$$

Maximum allowable tolerance for 6.065 standard run with beta of $0.59 = 1.3\%$.

A meter run of 5.955" diameter is a 1.8% variation from standard; therefore the standard (C) in the tables should not be used.

The value of (C) can be calculated as follows:

$$C = d^2ZL$$
$$d^2 = 12.25$$
$$Z = 218.1 \text{ (Table 804, page 89)}$$
$$L = 0.9985 \text{ (Table 803, page 88)}$$

Thus $C = 2667.7$

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The standard coefficient for 6.065-diameter 6 x 3.500 orifice = 2654.9.

(C) value of 5.955 dia. = 2667.7
(C) value of 6.065 dia. = 2654.9
Difference = 12.8 = + 0.5%

Coefficients for Meter Pressures Over 500 PSIG

When gas coefficients are calculated for meters operating on pressures over 500 psig, procedures outlined in Bulletin TS-461 should be followed. At these higher pressures the F_{e2} and F_R factors become negligible and may be omitted.

Manometer factor F_m, is introduced into the gas coefficient formula and takes the position of the $F_{e2}\,F_R$ combined factor in the formula. "In a mercury-type differential gage the fluid used to displace the mercury adds to the differential pressure produced across the orifice causing the meter to read high. When the displacing fluid is gas and the line pressure is below 500 pounds the error is too small to warrant inclusion as a correction to the metered volume. Above 500 pounds the correction factor F_m becomes sufficiently large to warrant its use."

Superexpansibility Factor F_{PV}: "These factors in TS-461 have been tabulated as functions of reduced pressure and reduced temperature, and are not as convenient for the user as the tabulations in TS-402 (as functions of specific gravity and flowing temperature). It was found necessary to tabulate in this manner in order to provide comparable accuracy, and to avoid an excessive tabulation of factors to cover the pressure and temperature range presented in this bulletin."

An example of the use of the F_{PV} and F_m tables as outlined in TS-461 is as follows:

Given conditions: Nitrogen (N_2) content 3.2%; specific gravity 0.635; temperature flowing gas 62°F; static pressure 730 psig.

Determination of F_{PV} and F_M

Table I	Sp. Gr. 0.635	Hydrocarbon P_c = 670	Hydrocarbon T_c = 368
Table II	N_2 = 3.2%	N_2 correction = −8 P_c = 670 − 8 = 662	N_2 correction = −13 T_c = 368 − 13 = 355
Table III	P = 730	P_{RC} (P = 700, P_c = 660) = 1.09	
Table IV	Interpolation aid	(Pressure) (Increment) = 30 (Difference) = .15 0.04 P_R at (P = 730, P_c = 662) = 1.13	
Table V	T = 62°	T_R = 1.46	
Table VI	(Page 17)	F_{PV} = 0.999	
Table VII	(Page 30)	F_M = 0.999	

$$C' = C \times MI \times F_m \times F_{PV} \times F_G \times F_T$$

The data are entered in Fig. 2.

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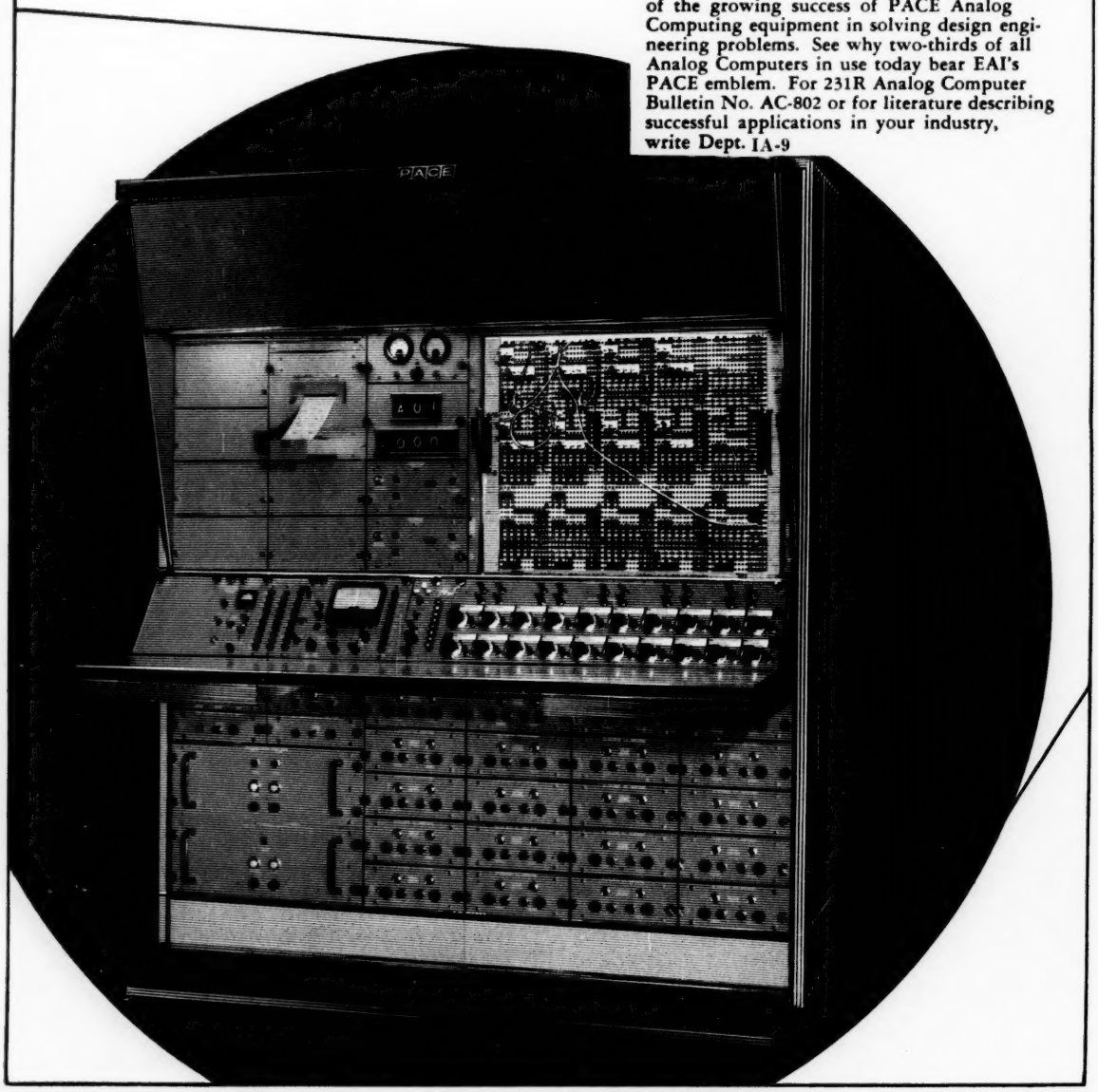

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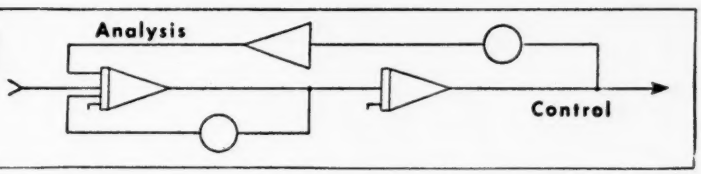
The SIMULATION COUNCIL Newsletter



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Bits

This month we have a report from *Bob Yaeger* on the June meeting of the Eastern Simulation Council, at which *Harold Skramstad*, *Arthur Ernst* and *James Nigro*, all of the National Bureau of Standards, discussed a combined analog-digital man-machine simulation system. Bob also gave us the gist of a talk by *Henry Bowes* on a "Universal Submarine Simulator" given at the almost-snowed-out February meeting of the ESC. Some of the facts we pass on to you under PIECES.

We also present under that heading condensed versions of talks by *Hans Meissinger* on "System Optimization by Steepest Descent Method," *George Brewer* on "A Technique of Simulation of Space Charge in an Electrolytic Tank," and *George Bekey* on "Applications of Automatic Programming Equipment," all of which were given at the July meeting of the Western Simulation Council.

Some points made at the Eastern SC Study Group on Physical Simulation are given with other miscellany under Info, and your Editor will try to corral a Thot sometime before he finishes this *Newsletter*.

Pieces

EASTERN S/C MEETING OF 16 JUNE ON "COMBINED ANALOG-DIGITAL SIMULATION"

About 70 members of the ESC attended the 16 June meeting at the National Bureau of Standards in Washington to hear *Harold Skramstad*, *Arthur Ernst*, and *James Nigro* (all of NBS) discuss "Combined Analog-Digital Simulation" and witness a demonstration of the NBS analog-digital man-machine system.

The NBS Man-Machine Simulator

Bob Yaeger (Electronic Associates, Inc., Long Branch, N. J.) tells us that most of the material presented was similar to that which was published in the *NBS Technical News Bulletin* of April '58, so here is a condensation of that writeup, which states that the Bureau has designed an advanced research tool which simulates interactions between electronic control systems and a team of human operators. The device, to be used for designing man-machine control systems such as those for air traffic control, ground control of interceptors, and command systems in general, was developed under the sponsorship of Wright Air Development Center, with the advice of psychologists from the Aero Medical Laboratory.

The research scientist's model, which enables him to investigate in detail particular phases of his problem, may be purely mathematical or, as at NBS, it may include a considerable array of complicated physical equipment.

The NBS prototype includes a digital computer and an analog computer, linked with display and control equipment which permits human beings* to be coupled into the system. The system provides an estimate of how the humans' alertness, judgment, and dexterity will affect otherwise automatic operations, and it thus can assess the reasonableness of tasks assigned to people in relation to their ability to perform them. The system is intended to deal with technical and economic factors which cannot be properly anticipated nor adequately resolved by a "paper study" alone; to achieve a better basis on which to specify the facility and to estimate the costs of constructing, operating, maintaining, and expanding it; and to test its utility by applying the prototype to the resolu-

*Or as our friend John Stroud of NEL would say, noisy two-legged computers.

tion of important issues now being faced in the development of control systems.

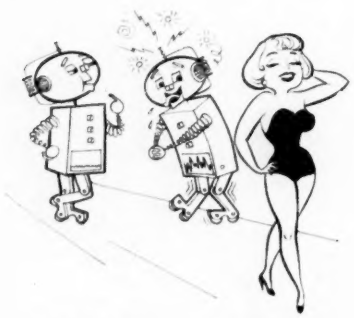
A simulator for man-machine systems differs in several distinct characteristics from one designed for purely automatic systems. It must operate in real time, must have appropriate data presentation for the human operators, and must provide for acceptance of human responses. You can't expect exact repeatability, and you must make much use of statistical methods in analyzing the experimental results. Since a human operator is extremely nonlinear*, the superposition process does not apply, and you must be sure that the simulation includes features of the human environment which are not directly a part of the control loop under study, but which may affect the loop significantly.

Analog computer equipment is used to accept continuous control information, solve complex dynamic equations in real time, and activate conventional display devices. Tasks for the digital computer include controlling the experiment, generating open-loop data, calculating with high precision, handling variables requiring large dynamic range, making logical decisions, and statistically analyzing experimental results.

The NBS system is particularly suited to the simulation of sampled-data systems—for example, a system involving human operators as components in a control loop, like the ground-controlled interceptor problem, which was simplified for study in the laboratory.

The digital computer is programmed to simulate a large number of aircraft observed by search radar. A console including CRT displays simulates the ground control station.

*Like those babes on the beach!—Ed.



I'm a non-linear man myself!
(*Courtesy Daystrom Systems*)

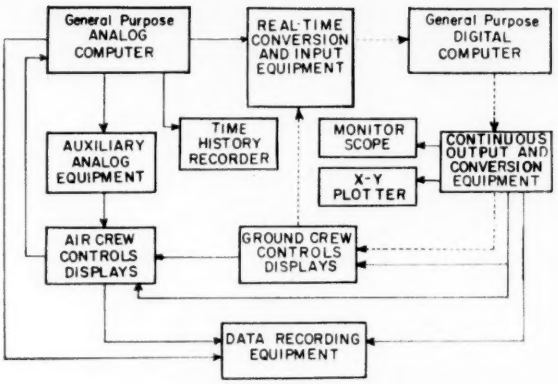


Fig. 1. The NBS man-machine system.

Aircraft are manually assigned and automatically tracked. A model of an airplane cockpit enables a human operator to imitate the actions of an interceptor pilot in flight. A control panel operated by the research team permits modification of the hypothetical situation under study.

A general-purpose electronic analog computer simulates the dynamics of the aircraft in real time and activates flight instruments in the cockpit, directly or through special-purpose analog equipment. The velocity components of the interceptor aircraft are converted to a ground reference system and integrated over one scanning period of the radar. These increments in position are then sent through specialized real-time conversion and input equipment to SEAC, an NBS general-purpose digital computer. SEAC stores the position of the controlled interceptor aircraft in its memory and updates the information at each sampling period of the system. The digital computer also controls the experiment, generates the trajectories of prej ogrammed aircraft, and simulates the interceptor control computer.

The output of SEAC is connected to specialized continuous output and conversion equipment which activates display equipment for the ground crew, operates a monitor scope, and sends data to an XY plotter on both a selected enemy target and an assigned interceptor. Navigation commands from the ground crew are sent to the air crew by voice or by a simulated data link which activates navigation instruments. Airplane controls operated by the pilot are signaled to the analog computer, thus closing the loop. A block diagram of the system is shown in Figure 1.

Any facility intended for research on man-machine systems will produce large quantities of experimental data. To draw conclusions from experiments as quickly as possible, some of the experimental data must be reduced during or between runs. Reduction between runs may be the more important, since combined simulation and data reduction might frequently make demands beyond the capacity of the digital computer. Also, the recording of data is desirable for analysis and comparison with subsequent experiments. Magnetic tape is used as the storage medium for experimental data in information blocks of 16 quantities at a recording frequency variable from 0.5 to 32 samples per second. The format is such that the tapes may be read into SEAC directly for further processing.

One advantage of the NBS facility is the ease with which the psychologist or engineer can modify his experiment rapidly and conveniently at the control panel. He need not be greatly concerned with programming difficulties, since changes are made by turning knobs or throwing switches on the control panel to modify the computer instructions, change system parameters, and control the selection of program subroutines.

EASTERN S/C MEETING OF 17 FEB. ON SUBMARINE SIMULATION

Henry Bowes (Electric Boat, Groton, Conn.) gave a talk to the Physical Simulation Study Group of the Eastern Simulation Council at AVCO Manufacturing Company in Lawrence, Massachusetts on February 17th. He covered the history of the use of simulation for training in submarine ship handling, and described the latest in shiphandling trainers now in operation at the Submarine School, New London Submarine Base, Connecticut. This trainer was built by the Electric Boat Division of

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An up-to-the-minute report on computer technology prepared by the **Beckman/Berkeley** *engineering staff*

This is the first in a series of advertisements designed to acquaint you with recent work undertaken by the computer engineering group at Beckman Instruments, Inc. This month we shall begin with a discussion of analog computer accuracy as a system concept, calling attention to a few points frequently overlooked when evaluating computers or when looking for possible sources of error. Future articles will deal with these and other points in greater detail.

Static Accuracy of Linear Components

This factor is perhaps the most important and certainly the most frequently cited. The ".01% computer" has been with us for years (at least in the literature, if not always in practice). It is almost trite to point out that the .01% figure refers to only one operation, static summation; in which accuracy is primarily dependent upon matching input and feedback resistors at d.c. While present day amplifiers with gains of 10^8 and low drift need hardly be considered in a discussion of static errors, the .01% resistors should be carefully examined: Are they only initially adjusted to .01%, or will they remain at that figure? Are they precise only at a particular temperature or over some range? Is .01% the average or the maximum error? Are resistors matched only in groups (e.g., input and feedback resistors of each amplifier or of a particular console) or are they set to an absolute value? These questions must be answered to make the .01% figure meaningful.

Dynamic Accuracy of Linear Components

Let us proceed from static to dynamic considerations. While it is not difficult to obtain amplifiers with a wide bandwidth, *phase shift* through the system can easily become the major source of problem error. Phase shift can be minimized in operational amplifiers by using computing resistors with closely controlled parasitic capacity. It can be further reduced by paralleling the input and feedback resistors with capacitors to extend the amplifier bandwith while maintaining equal time constants in the resistors. In doing this, however, the effect of the capacity on coefficient potentiometers which drive the amplifiers must be considered. An amplifier so compensated as to produce minimum phase shift from input resistor to output terminal will generally increase the phase shift through the coefficient potentiometer which drives it. Therefore, the compensating capacity must be selected for minimum phase shift through the overall system from pot input to amplifier output. In a later issue we will describe a simple method of evaluating phase shift using a patched-in three-amplifier oscillator.

Relay Timing

Computers are usually switched from one operating condition to another by means of relays. When going from the "hold" or "reset" condition to the "compute" condition or from "compute" to "hold," the time difference between contact closures or openings introduces an error in time-dependent circuits such as integrators. In the precision equipment available today this difference in relay contact times may cause a greater error than that introduced by all other components. Differential switching times of the order of 1 to 3 milliseconds have been considered "precise," but when we are trying to realize the accuracy of .01% operational components even a 2-millisecond time differential often introduces excessive error. Consider the commonplace integrator output curve shown in the diagram. Over a sizable arc this curve has a slope of 100v/sec. If integration begins 2.0ms late, the time difference will create a voltage error of 0.2v or 0.1% at all points within this region. To hold the voltage error down to .01% the difference in contact times should not exceed 0.2ms.

We hope that these pointers will be of some value to analog computer users. More detailed considerations will be presented in later issues. For a further analysis of phase shift we also refer you to "Extending the Bandwidth of Precision Analog Systems" by E. Billinghurst and C. Single, a paper to be given at the National Simulation Conference in Dallas, Texas, October 23-25, 1958.

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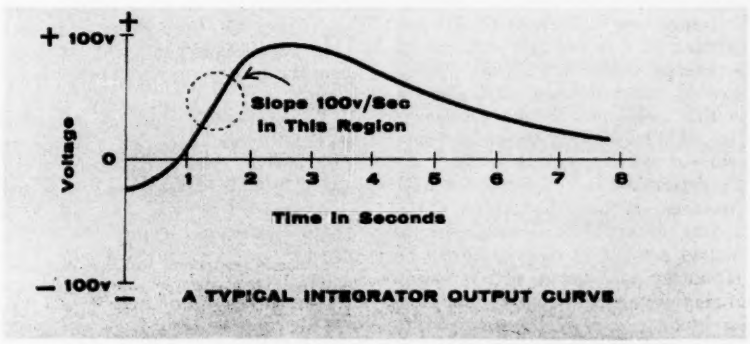

A TYPICAL INTEGRATOR OUTPUT CURVE

For more information circle 64 on inquiry card.

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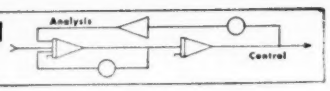

General Dynamics Corporation for the U. S. Naval Training Device Center in Port Washington, New York.

A description of the ballast tanks and control systems as well as the general characteristics of a submarine was given as background material, and the simulator then described in four major sections.

(1) The *training station* is a reproduction of the control room of the TRIGGER, SS564, with positions for a helmsman, bow and stern planesmen, air manifold operator, hydraulic manifold operator, trim manifold operator, and diving officer. The training station itself is mounted on a hydraulically-driven gimbal-mounted platform with limits of $\pm 45°$ in pitch and $\pm 30°$ in roll.

(2) The *instructor's station* is divided into problem preset, hull openings, ballast, speed, attitude, and air sections. The console operator in the instructor's station acts as the rest of the boat, inserts malfunctions into the various systems, and monitors the performance of the trainees.

(3) The *auxiliary machinery section* provides the necessary hydraulic power, air conditioning, and electric power distribution for the trainer.

(4) The *computing system* consists of a hydrodynamic* computer and the associated input and output systems. The hydrodynamic computation is performed by a DC analog computer** which contains 196 operational amplifiers, 21 servo multipliers, 27 relay amplifiers, and 225 potentiometers.

A second training station and instructor's console are being added to the original equipment to train submarine personnel on the nuclear vessels of today and tomorrow.

WESTERN S/C MEETING OF 11 JULY ON SYSTEM OPTIMIZATION

When *Dr. Robert K. Roney*, Manager of the Systems Analysis Laboratory at Hughes System Development Laboratories (Culver City, Calif.) welcomed the Western Simulation Council on 11 July 1958, history was made. Before *Hans Meissinger*, Head of the Dynamic Analysis and Simulation Section, arranged the meeting, it had never proved possible to consummate any of the Simulation Council meetings planned for Hughes. Good work, Hans!

Meissinger on Steepest Descent

After Dr. Roney's welcome, Hans described "System Optimization by Steepest Descent Method," a way of finding optimum solutions or optimum system parameters.

He gave a brief resume of computer applications of this method which have been described in the literature (see References 1 to 3) and referred to a recent textbook on experimental design by Davies (Reference 4) which devotes a full chapter to this technique. Typical problems amenable to solution by steepest descent (or ascent) named by Hans are the determination of minimum miss distances in missile guidance, the finding of stability boundaries of control systems, curve fitting by parameter adjustment, determination of maximum yield of a chemical process, etc.

Basically the approach consists in defining a function of several parameters of the system, called the response function or optimization criterion, which must be maximized or minimized in order to obtain an optimum condition. The search for stationary points on the response function proceeds along a path of steepest ascent or descent, as the case may be. After finding such a point it must be within the range of operating conditions being considered. Frequently the mathematical nature of the problem obviates the search for more than one stationary point. The steepest ascent or descent path is approximated in practice by varying the set of system parameters originally selected so as to follow the local gradient vector. The task, therefore, is to determine the gradient on the computer by a sequence of experimental steps at each operating point, or, if possible, by a direct computer program designed to yield the components of the gradient vector instantly.

To express the approach in mathematical terms, consider a response function of three parameters $h = f(a, b, c)$. At an originally selected operating point having the coordinates (a_o, b_o, c_o) in the three-dimensional parameter space the gradient

$$\nabla h = \left(\frac{\delta h}{\delta a}, \frac{\delta h}{\delta b}, \frac{\delta h}{\delta c} \right)$$ is determined,

and the parameters are then varied according to the steepest descent requirement

$$\Delta a = -k \frac{\delta h}{\delta a}$$

$$\Delta b = -k \frac{\delta h}{\delta b}$$

$$\Delta c = -k \frac{\delta h}{\delta c}$$

where k is a positive constant. (For steepest ascent the sign on the right hand side above is positive instead.) This leads to a new operating point with coordinates (a_1, b_1, c_1) which has an improved response function h. The process is then continued in the same manner until an optimum or near-optimum condition h_{max} or h_{min} is attained.

Hans distinguished between two types of gradient methods used on the analog computer—(a) continuous adjustment, applicable to algebraic systems, and (b) sequential adjustment in discrete steps, applicable to dynamic systems.

In the first case, the solution is obtained as a steady-state condition which the computer assumes automatically after the steepest descent adjustment has been completed, i.e., after the transients in the computer representation have subsided. Hence each solution is found by a single computer run. Examples of this approach are the solution of linear algebraic equations through a least-squares procedure as described by Gephart (Reference 1), polynomial solution and root-locus tracing as discussed in a paper by Meissinger and Levine (Reference 2) and a linear programming application published by Pyne (Reference 3). In the polynomial as well as in the linear programming applications, the computer program may utilize smooth integration towards the optimum or on-off type adjustment when certain boundaries of the response function are reached along which the adjust-

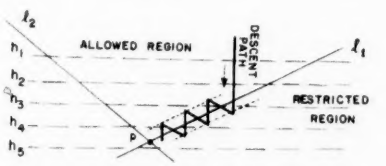

Fig. 2. Descent path for a 2-dimensional linear programming problem.

*Pneumatic computers we have designed, electronic computers we have lived with, but hydrodynamic computers? ?—Ed.

**Oh!!

ment must continue. Such a descent path for a two-dimensional linear programming problem is shown in Figure 2. The optimum is located at the minimum level of the response function h at the intersection P of two straight boundaries l_1 and l_2 representing subsidiary conditions of the process under investigation.

The case of adjustment by discrete steps is typified by the successive solution of a guidance problem where miss distance is the criterion of optimum design. A sequence of trial runs must be performed to obtain information for the response function and its gradient, and the parameter adjustment is then made incrementally along the gradient. The difference between this and the former case obviously arises due to the time-sweep required for problems having time as the independent variable so that continuous parameter variation with time is not feasible except by means of high-speed repetitive computer operation. Thus dynamic system optimization must be performed manually by the operator, or it requires automatic sequencing equipment for implementation of the step-by-step process along the gradient.

Hans then discussed the mathematical concept of parameter influences, which he thinks is very useful in any automatic system optmization procedure. He has a paper on the subject, soon to be published. In brief, the technique consists in finding the partial derivatives or "parameter influences" of pertinent problem variables, which can be obtained directly from the computer if certain auxiliary equations are programmed into it. In other words, a trade-off between computing equipment required and time required for problem solution can be accomplished in this manner. The parameter influences thus obtained either represent the gradient components directly or may be processed to yield the gradient, depending on the choice of the response function.

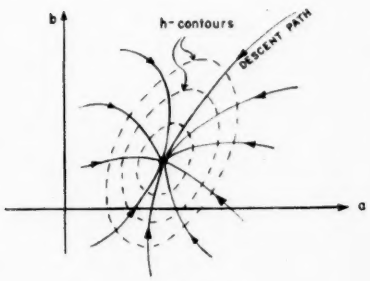

Fig. 3

The discussion concluded with an example involving the adjustment of the coefficients of a linear differential equation for least-square curve fitting. The simple case of a second order system was studied on the computer and the parameter influence technique was used to yield the gradient of the response function which, in this case, was chosen to be the integral

$$h(a, b) = \int_0^T \epsilon^2(a, b)\, dt$$

Figure 3 shows the contours and gradient curves of the response function h in the a.b-plane as obtained on the computer. Hans said that the technique was to be tried on more complex linear and nonlinear systems to determine the degree of practical usefulness in problems like the analysis of flight-test data.

In the discussion that followed Hans' speech it was asked whether, in linear programming as illustrated by the example of Figure 2, the computer approach is necessary for such a simple problem. The answer was that usually problems involve n-dimensional parameter manifolds with m subsidiary conditions where m and n are rather large. Here the analytical or numerical approach is left far behind the effectiveness of computer operation.

Further comments indicated that steepest descent using a fixed proportionality factor K in all directions may not be the most effective approach; a suitable non-uniform weighting of the various components may be preferable. One valid objection to the steepest descent method is the sometimes-insufficient knowledge it provides on absolute optimum conditions if the system has a large number of relative optima. Whether such is the case is sometimes hard to determine in advance.

References on the Steepest Descent Method

1. F. L. Gephart, "Linear Algebraic Systems and the REAC," Math. Tables and other aids for Comp., 6, pp 190-203, (1952).
2. H. F. Meissinger and L. Levine, "An Automatic Computer Circuit for Solving Polynomials and Finding Root Loci," *IRE Convention Record*, 1957, Part 4, pp 164-172.
3. I. B. Pyne, "Linear Programming on an Analog Computer," *AIEE Trans.* 1956, Part I, pp 139-143.
4. O. L. Davies, *Design and Analysis of Industrial Experiments*, Chapter 11, Hafner, New York, 1956.

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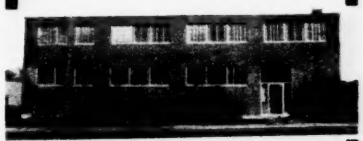

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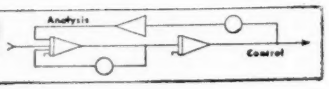

BEKEY ON AUTOMATIC PROGRAMMING

At the same Hughes meeting *Duane Beecher* (Hughes) spoke on "Automatic Sequencing of Computers to Handle Noise Inputs and Change of Parameters," *George Bekey* (Ramo-Wooldridge) spoke on "Applications of Automatic Programming Equipment," *Bill Kindle* (EAI Computation Center, El Segundo, Calif.) described problems which they had actually solved using automatic techniques. *George Brewer* (Hughes) described a technique for simulating space charges, and *Fred Williams* (Hughes Human Factors Engineering Section, Radar Department) gave a general rundown of Hughes simulation activities and equipment prior to the guided tour. Only George Bekey and George Brewer's talks are abstracted this month because (1) They are the only ones that gave me complete information; (2) I hope to be able to get the straight scoop from the others before next month's *Newsletter;* and (3) this *Newsletter* is too long anyway!

* * *

Automatic sequencing and programming equipment, George Bekey said, make it possible for the analog computer to adjust its parameters, perform certain logical decision functions, proceed from one solution to another, control input and output equipment, or stop the computation in accordance with pre-selected criteria, and thus to exhibit some of the versatility of the digital computer. George reviewed some applications in which automatic programming equipment was used to provide changes in problem parameters from solution to solution. This requires considerable computing time, since it involves automatic operation of the computer for many runs. Among techniques which have been developed to avoid the need for automatic programming equipment are the method of steepest descent for finding the roots of polynomials, and the adjoint computing technique for finding the weighting function of a linear time-varying system. These methods provide information in a single computer run which would otherwise require many runs.

Automatic programming is a technique which does not necessarily require specially constructed equipment. Examples are the simulation of a bouncing ball which introduces an upward force when the ball hits the ground, or the use of relays to switch scale factors during solution of a problem.

Statistical Problems represent one of the most important areas of application of automatic programming equipment. Examples are:

(a) Measurement of the characteristics of random noise, like rms value and amplitude distribution. These require the recording of the results of many runs to obtain high confidence limits.

(b) Evaluation of random variables, such as miss distance of a missile subjected to random noise.

(c) Evaluation of certain statistical functions which are difficult to handle analytically, like obtaining the probability that a fading signal with a certain probability distribution will fade below a given threshold for a given time.

By means of automatic programming techniques the computer can be made to proceed stepwise along successive steps of *Difference Equation*[3]. Recent papers have discussed the use of such a technique to simulate, on the analog computer, digital integration schemes, certain digital filters, and sampled data systems.

Two applications of *Parameter Adjustments* are:

(a) Plotting families of curves, with the programmer being set to change parameters and reposition the plotting pens between runs.

(b) Evaluation of certain integral transforms, of the general form,

$$F(x) = \int_a^b K(x,t) f(t)\,dt \qquad (1)$$

where the computer performs the integration for successive values of x and plots F(x), point-by-point, as a function of x. Fourier, Laplace, and Hilbert transforms are of this general form.

Automatic programming can also be used for the *Expansion of a Function in Orthogonal Series.* If a function f(t) is expanded in a series of orthogonal functions $P_n(t)$, i.e.:

$$f(t) \rightarrow \sum_{n=1}^{\infty} a_n P_n(t) \qquad (2)$$

the coefficients a_n are given by a relation of the form

$$a_n = \int_a^b P_n(t) f(t)\,dt \qquad (3)$$

The computer can be programmed to compute a_n for successive values of n, and thus calculate the coefficients of a Fourier, Tsebyscheff, or Laguerre series.

Successive evaluation of integral transforms makes it possible to solve *Integral Equations* such as

$$\phi(x) = g(x) + \beta \int_a^b K(x,t)\phi(t)\,dt \qquad (4)$$

the solution of which can be obtained from the successively iterated transform

$$\phi_n(x) = \int_a^b K(x,t)\,\phi_{n-1}(t)\,dt \qquad (5)$$

and

$$\phi(x) = \phi_0(x) + \beta\,\phi_1(x) + \beta^2\phi_2(x) + \ldots. \qquad (6)$$

Given a series representation of a function f(t),

$$f(t) = \sum_{n=0}^{\infty} A_n Q_n(t) \qquad (7)$$

the use of sampling and sequencing equipment makes it possible to *Evaluate the Infinite Series* by allowing the variable n to operate continuously for fixed values of time. Function generators can be used to obtain A(n) and $Q_t(n)$. If these are multiplied, and the product sampled at integral values of n and the samples accumulated, a value of f(t) is obtained for the time t_1.

Bode Diagrams can be plotted automatically using automatic programming equipment, once the transfer function of a system has been simulated on the analog computer. The programmer introduces a certain frequency f_1 into the system. The output oscillation is compared in phase and amplitude with the input, and a point is obtained for the Bode diagram. Differentiation, rectification, and filtering of the input sine wave produces a d-c voltage proportional to frequency. A function generator can be used to provide log frequency for the abscissa of the x-y plotters, which will then plot amplitude ratio and phase vs. log frequency, point-by-point at pre-selected values of frequency.

A number of applications of automatic programming equipment were discussed. George said that the list is by no means exhaustive, since new applications are continually being made in many computer laboratories. He would like to hear from others interested in broadening the scope of

analog computer applications by using programming equipment.*

Brewer on Space Charge Simulation

George Brewer, Section Head, Electron Dynamics Department of the Hughes Physics Lab., speaking on "A Technique of Simulation of Space Charge in an Electrolytic Tank," said that the electrolytic tank has been used for many years to provide solutions of the Laplace equation ($\nabla^2 V = 0$) in physical problems for which an analytical solution is difficult. However, the usefulness of the electrolytic tank analog for obtaining solutions of problems in which the field distribution is described by the Poisson equation ($\nabla^2 V = \zeta/\epsilon_0$) has been limited because of the lack of a suitable technique for the simulation of the space charge (the term on the right side of the Poisson equation) in the tank. A satisfactory method for space-charge simulation in an electrolytic tank, allowing analog solution of the Poisson equation, was described. This technique has been used to simulate the space charge in high perveance cylindrically-symmetric electron guns, allowing the trajectories of the electrons to be traced accurately.

Figure 4 shows the electron-trajectory-tracing apparatus involving twin wedge-shaped electrolytic tanks, one for the electric fields in the gun and a second to include the effects, if any, of magnetic fields present in the gun. In the tank on the left can be seen the space-charge simulating elements, which take the form of wire probes projecting up from the bottom of the tank in regions where the water is deep. In the shallow water (near the axis of the wedge) these elements take the form of distributed current sources composed of ordinary carbon resistors (the black dots in the photograph). The space-charge simulation current in each probe is related to the charge density and velocity at each point by using an iterative process starting from the space-charge-free situation.

Experimental tests have shown that this technique is capable of providing solutions for the potential within an accuracy of 0.25% in a one-dimensional problem. The complete electron trajectories, a two-dimensional problem, also have been checked experimentally within an accuracy of a few percent. George explained that more details of this technique are contained in a paper to be published in the *Journal of Applied Physics*.

*George's address is Guided Missile Research Division, Ramo-Wooldridge Corp., P.O. Box 45564 Airport Station, Los Angeles 45, Calif.

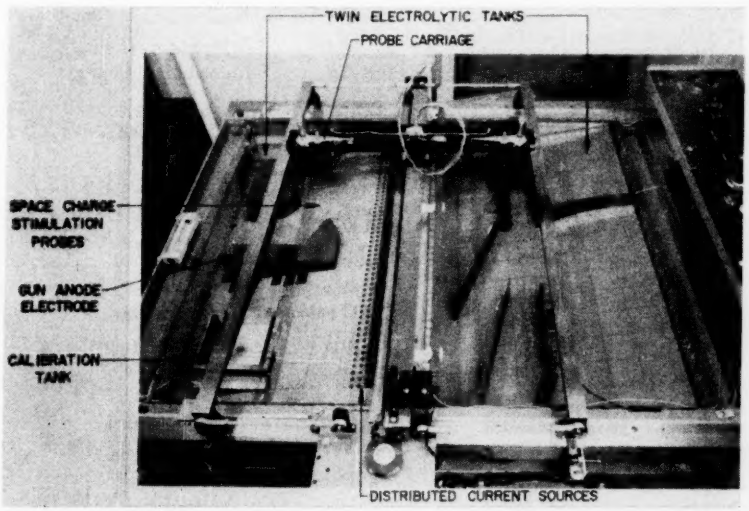

Fig. 4. Electron-trajectory tracing apparatus in electrolytic tank.

Information (Without Theory)

This we will watch with interest. Mid-Century Instrumatic Corporation (New York, N.Y.) has announced a trade-in policy which will allow trade-ins of older equipment for discounts on new machines ranging up to 50% of selling price. The trade-ins will be *sold or leased* to users in new industries at attractively low rates.

Such a policy, if successful, will certainly benefit the whole industry. However, if a way is not found to assure that the reliability of the used equipment is at least as good as that of (and preferably better than) new equipment, it could sour proposective users and backfire with very unhappy results.

* * *

We understand *Herb Wexler's* Physical Simulation Study Group of the Eastern Simulation Council had quite a discussion at their June 16th meeting on transducers and the maintenance of special simulation equipment. *Jim Wolle* (General Electric, Philadelphia, Penna.), *Marge Albrecht* (Sperry Marine Division), *Herb* (AVCO, Lawrence, Mass.), and the others agreed that potentiometer-type pressure transducers have repeatedly demonstrated sticking, offset and hysteresis problems, while strain-gauges present the problem of very low-level outputs in the order of millivolts.

* * *

" 'Per aspera ad astra—Over all obstacles up to the stars:' The start has been made and it is only a matter of time until the first manned vehicles will rise to explore outer space."

The Convair-Astronautics Training Section has published a "Rocket Thesaurus," a handbook designed to serve as a handy reference guide offering data drawn from the several sciences with which space technology is concerned. Also, a selective glossary representing these fields is included. We hope that engineers, technicians, and interested persons everywhere will find this handbook useful in the ever-growing missile and satellite fields.

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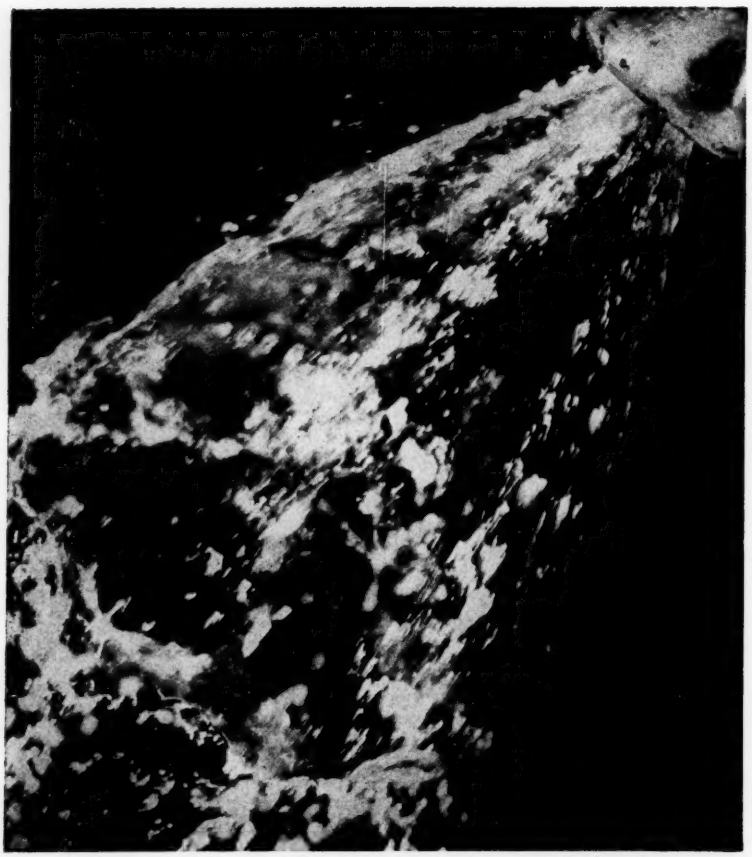

To show fluid volume, photographer Bernard Hoffman uses the free discharge of water from an ordinary garden hose.

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He Went Thataway!

Tim Sutton to Acoustica Associates, Mineola, New York.

Thot

Because Suzette typed the manuscript for this *Newsletter* at between 65 and 70 mph somewhere between San Bernardino, Calif. and Jordan Valley, Oregon, the only thought that I can offer at the moment is: Thank heaven for fast secretaries!

Computer Events

National Electronics Conference

Dates: October 13-15, 1958
Place: Chicago, Ill.

National Simulation Conference

Dates: 23-25 October 1958
Place: Statler-Hilton Hotel, Dallas, Tex.
The conference will be sponsored by the IRE PGEC and the Dallas Section of the IRE. For further information write J. E. Howard, 2100 Menefee Drive, Arlington, Texas.

Eastern Joint Computer Conference

Dates: 3-5 December 1958
Place: Philadelphia, Penna.

High-Speed Computer Conference

Dates: 10-13 February 1959
Place: Louisiana State University Baton Rouge, Louisiana

Western Joint Computer Conference

Dates: 3-5 March 1959
Place: San Francisco, California

Computer Applications Symposium

Dates: 29-30 October 1958
Place: Armour Research Foundation Chicago, Illinois

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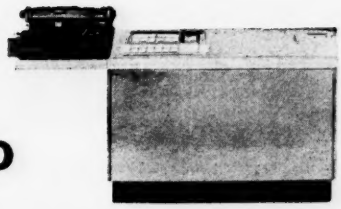

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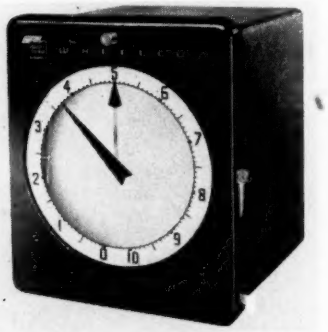

and swing-out design. Pen speed is 1, 4 or 20 sec at 60 cps. Instrument accuracy is $\pm\frac{1}{4}$ of 1% for all scale spans in the pyrometric range. All recorder-controllers and circular scale controllers are available with the Wheelco three-function control forms. —*Barber-Colman Co., Wheelco Instruments Div.*, 1300 *Rock St., Rockford, Ill.*

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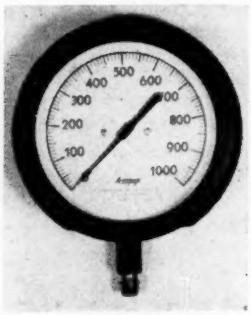
LONG-BOURDON-TUBE GAGES

New Acragages with blowout disc have Bourdon tubes 10% to 15% longer than those generally used. This allows the use of heavier-walled tubing with operation well below

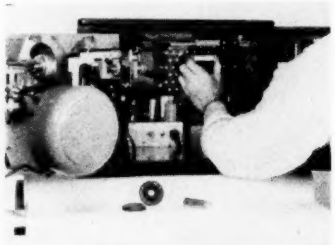


elastic limit, insuring increasing repeatability; also greater tip travel with greater accuracy. Materials are phosphor bronze, alloy steel, type 316 and 403 s.s., and K-Monel.—*International Register Co., Instrument Div.*, 2630 *W. Washington Blvd., Chicago* 12, *Ill.*

For more information circle **213** on inquiry card.

FLEXIBLE MULTIPOINT RECORDER

New Model 6702 is 2- to 24-point strip chart recording potentiometer of flexible design which permits varying the number of points, the desired ranges, and types of thermocouples without changing external wiring, soldering, or refitting of com-

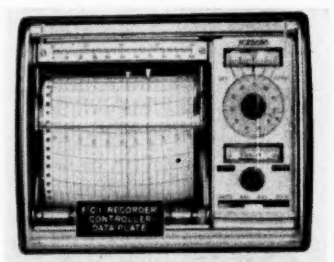


ponents. Point changes are effected by replacing (1) the number-of-stations plug, (2) the station indicator plate, and (3) the print wheel. The range is altered by substituting one range clip for another. Thermocouple types are exchanged by inserting a different terminal board. Handy change kit contains all parts. Accuracy of one-price instrument is $\frac{1}{4}$%. —*Daystrom-Weston Industrial Div., Daystrom, Inc., Poughkeepsie, N. Y.*

For more information circle **214** on inquiry card.

ELECTRONIC CONTROLS

New line of basically 6" x 6" Consotrol instruments with electronic control include transmitters, recorders, controllers and valve operators. Featured are solid-state elements,

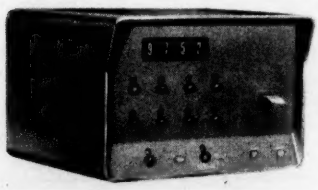


choice of motion-balance or force-balance transmitters, electrical measurement converters front-of-panel mounting. 4" strip-chart recorder Model 64 has powerful deflection motor operating directly from the transmitted 10-50 ma d-c measurement signal to drive the recorder pen.—*The Foxboro Co., Foxboro, Mass.*

For more information circle **215** on inquiry card.

COUNTER/CONTROLLER

New BD-1 solid-state counter/controllers incorporating printed readout are furnished with single or dual preset up to six digits. Presetting is



indicated on illuminated number dials. Input signal: between +50 v and −50 v. Counting rates: up to 100 kc (1 mc special). As time function controller, rpm, flow or linear speed can be controlled at a single set point.—*Presin Co.*, 12128 *W. Pico Blvd., West Los Angeles* 64, *Calif.*

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V/D CONVERTER

New Voldicon Model V16-AD is a high-speed four-decimal digit voltage-to-digital converter for rigorous linearity and accuracy, featuring 1000 independent conversions per sec.

Inputs are full scale 1, 10, and 100 volts. Outputs include visual displays ("Super Nixies") binary coded decimal (4-2-2-1 code), decimal output, etc.—*Adage Inc., Dept., P*, 292 *Main St., Cambridge* 42, *Mass.*

For more information circle **217** on inquiry card.

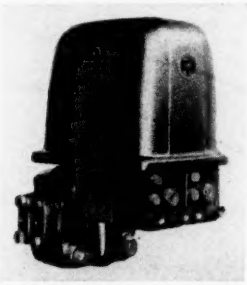
CONTACT-MAKING INSTRUMENT

New Model 1094 AC Sensitrol Relay employs a moving-iron mechanism (no need for rectifiers or external converters); deflects in proportion to true rms value (surpassing rectifier types which respond to average values and are affected by wave-form errors and temperature effects); is available with either one or two preset contacts and in current or voltage ranges; normally adjusted for 25-125 cps but available also for either 400 or 800 cps. Voltage ranges from 6 to 300 and current ranges from 3 ma to 5 amp.—*Daystrom, Inc., Weston Instruments, Newark* 12, *N. J.*

For more information circle **218** on inquiry card.

FORCE-BALANCE TRANSMITTERS

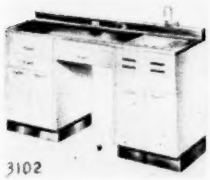
New f/b-LINE are force-balance pneumatic transmitters for flow, differential pressure, level, and specific gravity, having a min. range span of 0-2" WC with service pressures to 50 psig; max. range is 0-2000" WC with service pressures to 5000 psig.



Stability is maintained by a newly developed reset-type booster relay. For flow it has a built-in square-root extractor emitting a linear rate-of-flow signal. Three standard measuring diaphragms provide all ranges. 10:1 differential range change is possible with simple screwdriver adjustment. Air consumption is only 0.07 scfm at balance on dead end service. Product specifications P21-7 and P22-2 available.—*Bailey Meter Co.*, 1050 *Ivanhoe Rd.*, *Cleveland* 10, *Ohio.*

For more information circle **219** on inquiry card.

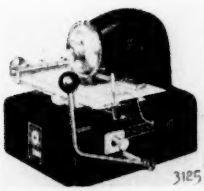
MODULAR LAB CABINETS



New complete line comprises base cabinets as single units or in series to fit a given area, knee-hole units, sink cabinets and corner cabinets, hanging wall base cabinets; also accessories including sinks, goose-neck faucets, electric outlet, air and gas cocks, etc.—*W. D. Allison Co.*, 1133 *Burdsal Parkway*, *Indianapolis*, *Ind.*

For more information circle **220** on inquiry card.

DETAIL PRESS



New and improved hand-operated detail press, for low-production name-plate and small-part stamping, features automatic spacing and alignment of work. Operating lever will deliver up to two tons pressure on work area for marking in hard materials such as stainless steel. Marking depth and pressure can be preset.—*Defiance Machine & Tool Co.*, 1920 *S. Vandeventer Ave.*, *St. Louis* 10, *Mo.*

For more information circle **221** on inquiry card.

Performance-Proved

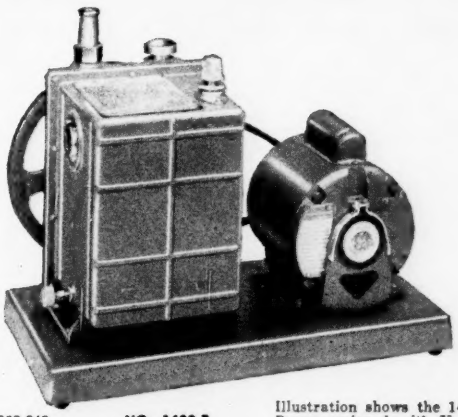
Welch DUO-SEAL VACUUM PUMP

TWO-STAGE CONSTRUCTION

with VENTED-EXHAUST

PATENT PENDING

• Large Capacity–High Vacuum
• Effective Fast Removal of All Vapors
• Quiet Operation
• Economical To Run And Maintain



PAT. NO. 2,337,849 NO. 1402-B

Illustration shows the 1402B Duo-Seal Pump equipped with Vented Exhaust.

GUARANTEED VACUUM—with vent closed 0.1 micron. When the vent is open, only slightly higher ultimate pressures result—usually in the range of 1 micron

FREE AIR CAPACITY—140 liters/minute (5 cubic feet)

PUMPING SPEED		
At	Vented Exhaust Closed	Vented Exhaust Open
1000 MICRONS	110 L/M	100 L/M
100 MICRONS	100 L/M	92 L/M
10 MICRONS	92 L/M	68 L/M
1 MICRON	76 L/M	28 L/M

1402. DUO-SEAL VACUUM PUMP, Unmounted.
With pulley, but without motor, belt or base.
Each, $240.00

1402B. DUO-SEAL VACUUM PUMP, Motor Driven.
For 115 Volts, 60 Cycles, A.C. **Each, $310.00**

1402C. DUO-SEAL VACUUM PUMP, Motor Driven.
For 230 Volts, 60 Cycles, A.C. **Each, $310.00**

1402D. DUO-SEAL VACUUM PUMP, Motor Driven.
For 115 Volts, D.C. **Each, $416.50**

For attached Belt Guard, add $17.50 to above prices.

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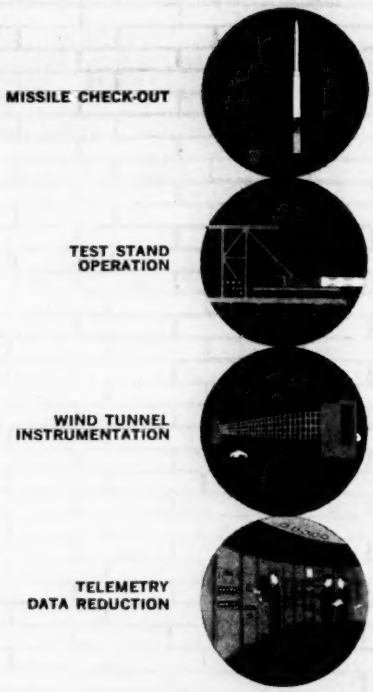
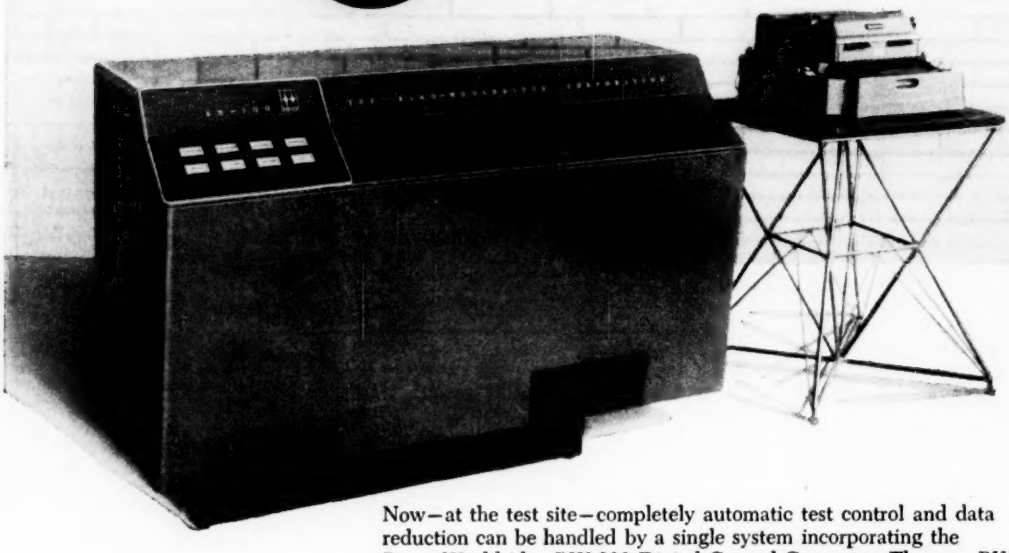
Manufacturers of Scientific Instruments and Laboratory Apparatus

For more information circle **68** on inquiry card.

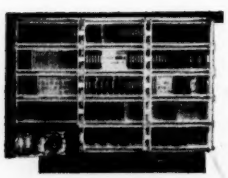


The RW-300 is the first digital computer for test control and data reduction



Now—at the test site—completely automatic test control and data reduction can be handled by a single system incorporating the Ramo-Wooldridge RW-300 Digital Control Computer. The new RW-300 can schedule and closely control test routines, and it can collect, analyze, and record test data.

The versatile RW-300 utilizes input data as feedback to modify control actions, thus substantially shortening many test routines. In addition, the RW-300 directly logs both instrument data and complex relationships among these data. Thus, test results are available immediately. The time-consuming task of processing raw data through a separate computer, often remote from the test facility, usually can be eliminated.

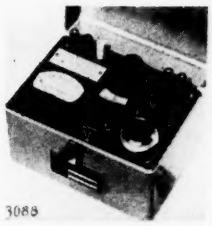


For technical information on automatic test control and data reduction with the RW-300 and with special digital systems which utilize solid-state components exclusively, write: Director of Marketing, The Thompson-Ramo-Wooldridge Products Company, P.O. Box 45607, Airport Station, Los Angeles 45, California, or call OSborne 5-4601.

THE THOMPSON-RAMO-WOOLDRIDGE PRODUCTS COMPANY

For more information circle **69** on inquiry card.

PROCESS CONTROL TESTER



New Model MV-1 combines all functions of a precision potentiometer, a precision millivolt source and a high-grade milliammeter; provides all facilities for testing, calibrating or servicing process controllers and amplifiers which convert millivolt input signals into proportional currents for control or telemetering. Potentiometer section ranges: 0-60 mv and 95-105 mv. Voltage decade switch provides seven millivoltage taps and multiturn slidewire dial provides 0-10 mv in 2.5-uv increments (particularly useful for measuring outputs of primary measuring elements). Many additional features include standard cell, 0.1% accuracy, guarded output circuit and internal mercury battery power. —*Technique Associates, Inc., P. O. Box 91, Indianapolis 6, Ind.*

For more information circle **222** on inquiry card.

SUBMINIATURE DELAY RELAYS

New delay lines meet requirements of MIL-C-15305A, Grade 1, Class B; are ultra-compact (example: 1-usec

1000-ohm line has a delay-bandwidth product per cubic inch of over 7.5); can be stacked in series to give higher delays, or tap-off points used to give lower delays. Impedances from 500 to 2000 ohms; delays up to 1 usec; operating temperature range −55°C to 125°C. Maximum risetime for longest delay is only 0.15 usec.—*NYT Electronics, Inc., 2979 N. Ontario St., Burbank, Calif.*

For more information circle **223** on inquiry card.

DC POWER SUPPLY

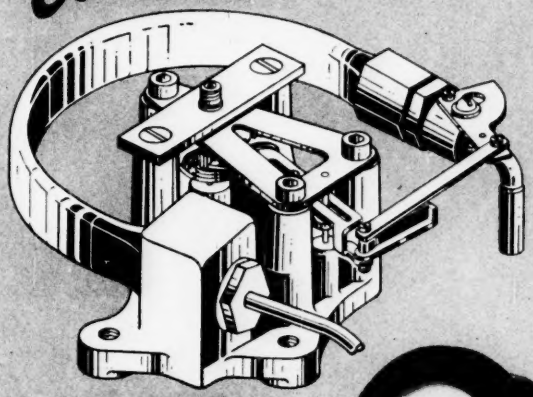
New twin transistorized Unireg Model TQ-36 delivers 4-36 v, 0-1 amp, features 0.1% regulation for line or

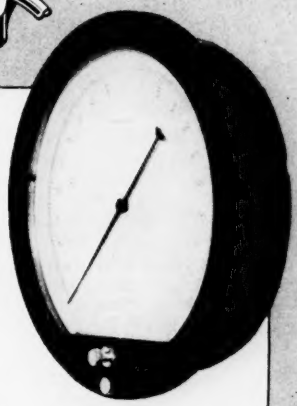
load, typical transient response 50 usec, ripple < 3 mv, stability 0.05 v for 8 hr. Each unit is completely independent.—*Universal Electronics Co., 1720 22nd St., Santa Monica, Calif.*

For more information circle **224** on inquiry card.

HEISE GAUGES

NEW Automatic Thermal Compensator





Heat and cold have no effect on the Heise High Precision Pressure Gauge equipped with the new Thermal Compensator. (Patent applied for)

Developed by the Heise Laboratories, manufacturers of the world's finest pressure measuring instruments, this unique device now eliminates all error due to thermal variations. Pointer errors caused by linkage growth and changing modulus in the Bourdon Tube are positively and precisely compensated by the equal and opposite action of a scientifically designed and balanced bimetal bar to maintain calibration through a temperature range from 0° to 100°F.

Even exposed to rapidly changing weather outside the confines of the laboratory, the Heise Gauge upholds its traditional position as

THE STANDARD OF THE WORLD

Pressure Ranges 15 to 20,000 P.S.I. Dial Sizes 8½"-12"-16"

Prices from $196.75 **DELIVERY WITHIN 30 DAYS**

Write for Catalog

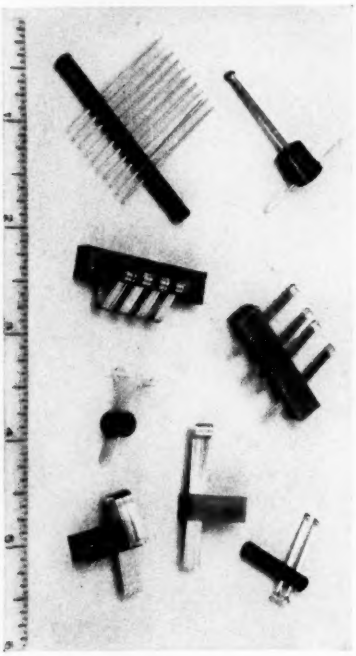
HEISE BOURDON TUBE COMPANY, INC.

BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

For more information circle **70** on inquiry card.

announcing

NEY MOLDED CONTACT ASSEMBLIES



Impressive cost savings and greater reliability are inherent in the use of the new Ney molded contact assemblies. For use with printed commutators, potentiometer windings, slip ring assemblies and printed rotary switches, these assemblies are available in a standard line now being manufactured by Ney, or can be designed to customer specifications.

Seven prime advantages are (1) a complete single or multiple brush assembly ready to use, (2) no welding or soldering, (3) reduction of adjustment during assembly into unit, (4) insured uniformity of desired gram pressure, (5) reduced inspection costs, (6) time tested Ney alloys for reliability, (7) will withstand extremes in operating environments.

SEND FOR LITERATURE

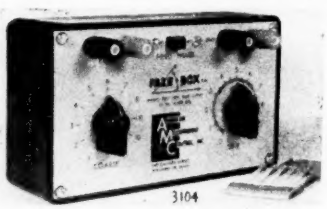
The J. M. Ney Company

P.O. Box 990, Dept. F, Hartford 1, Conn.

For more information circle **89** on inquiry card.

PHASE SHIFTER

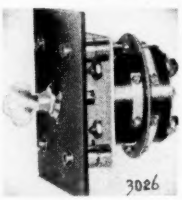
New Faze-Box, when inserted into circuit, enables user to change phase from 0 to ±180° in seconds. Input



up to 30 v rms; frequency 25 to 10,000 cps; output voltage has same amplitude as input. Impedance about 15,000 ohms under usual conditions. —*American Measurement & Control, Inc.*, 240 *Calvery St., Waltham, Mass.*

For more information circle **225** on inquiry card.

ROTARY SWITCH

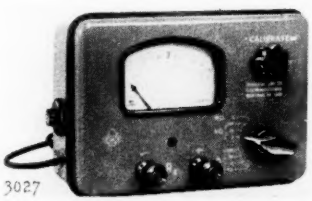


New key-operated Type JR provides tamper-proof control of complex circuits; key serves as knob and, when removed, locks switch in selected position. Switch provides control of up to three sections, eight positions; can be locked in any of the eight positions by key removal. Rating: 10 amp 125 vac, 5 amp 125 vdc.—*Electro Switch Corp., Weymouth* 88, *Mass.*

For more information circle **226** on inquiry card.

OHMMETER

New Model 321 is said to be "the first and only direct-reading ohmmeter usable safely in all transistor



circuitry." Its eight ranges cover 10 milliohms to 10 megohms.—*Electronic Applications*, 194 *Richmond Hill Ave., Stamford, Conn.*

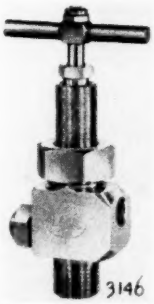
For more information circle **227** on inquiry card.

AUTOMATIC TIMER

New synchronous motor-driven timer is available with 1-, 3- and 5-min timing units adjustable in 1-sec, 3-sec and 5-sec increments respectively; features ease of time settings, and exclusive terminal-board and mounting-base combination. Motor operates on 110 v 60 cps. For 220, 440 or 550 v 60 cps, a control transformer and terminal block are added. In all instances interchangeability feature applies.—*Cutler-Hammer Inc.*, 503 *N. 12th St., Milwaukee* 1, *Wis.*

For more information circle **228** on inquiry card.

CYLINDER VALVE

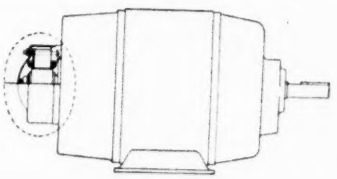


New PY 3000 Series angle-pattern stainless-steel cylinder valve for services up to 3000 psi features union bonnet design permitting interchangeability of stainless steel blunt stem plug or flat Teflon disc stem plug; can be supplied with either (1) safety disc, four bursting ranges from 1400-1600 psi to 3600-4000 psi; or (2) spring-loaded relief valve, four relief pressure ranges from 150-175 psi to 540-600 psi.—*Hoke Inc.*, 231 *So. Dean St., Englewood, N. J.*

For more information circle **229** on inquiry card.

TACHOMETER GENERATOR

New Tachometer Generator designed for direct mounting to driving motor yields ac output whose fre-



quency is 4 times fundamental motor speed (e.g. 240 cps at 3600 rpm). Either output frequency or voltage can be used for speed indication, as both are directly proportional to rotor rpm. Motor may operate in either direction.—*Carter Motor Co.*, 2704 *A West George St., Chicago* 18, *Ill.*

For more information circle **230** on inquiry card.

MOISTURE MONITOR

New Type 26-302 Moisture Monitor measures water content accurately down to 10 ppm full-scale; reads over range of 0 to 20,000 ppm by means of a 6-position attenuator. Output of analyzer can be telemetered to a remote recorder for monitoring or control. Adjustable output voltage to recorder is 10 to 110 mv full-scale. —*Consolidated Electrodynamics Corp.*, 300 *N. Sierra Madre Villa, Pasadena, Calif.*

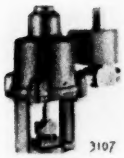
For more information circle **231** on inquiry card.

PNEUMATIC PRESSES

New 500-lb PH2 and 1700-lb PH3 high-precision pneumatic presses, for production and assembly, operate on 85 psi air line pressure; feature micrometer depth stop with guaranteed accuracy of 0.0001", stroke adjustable to 1.18", ram speed set by variable control which does not alter applied force.—*American LIP Corp.*, 610 *Fifth Ave., New York* 20, *N. Y.*

For more information circle **420** on inquiry card.

POWER CYLINDERS

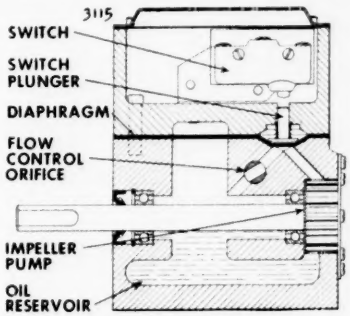


New heavy-duty industrial-type solenoid-controlled cylinders are single-acting, controlled by a 3-way solenoid valve arranged to alternately apply or vent pressure, operate on air, water or oil at pressures from 10 to 150 psi, and at any standard ac or dc voltage.—*Automatic Switch Co., Florham Park, N. J.*

For more information circle **421** on inquiry card.

MOTION INDICATOR

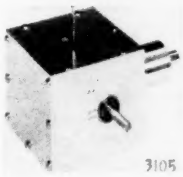
New Roto-Guard utilizes pump to convert motion into a pressure-drop signal which can actuate an alarm



system or control switches; is adjustable within speed range of 10 to 150 rpm; has ½" drive shaft.—*The Bin-Dicator Co.*, 13946-226 *Kercheval Ave., Detroit* 15, *Mich.*

For more information circle **422** on inquiry card.

VARIABLE SPEED DEVICE

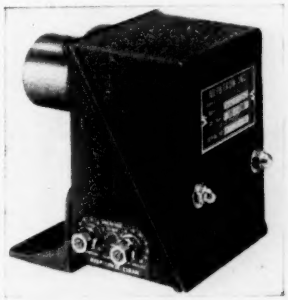


New Ring Integrator comprises a movable ring held between a driving disc and a driven drum. Movable ring can be accurately controlled or repositioned by <0.02 oz force as output shaft load varies from 0 to 2 oz-in. Output shaft speeds of 0 to 2.75 times input speed can be obtained. Device can be used as an integrator or precision variable speed drive for chart drives, Btu meters, rate generators, servomechanisms, computers, etc.—*American Meter Co., Components Dept. Box* 306, *Garland, Texas.*

For more information circle **423** on inquiry card.

PHOTOELECTRIC TIMER

New improved photoelectric timing control features sharp time delay adjustment over a range of 1 to 10



seconds. Contacts are sp-dt rated 8 amp @ 115 vac.—*Autotron, Inc., Box* 722*Q, Danville, Ill.*

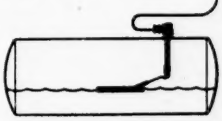
For more information circle **424** on inquiry card.

100% AUTOMATIC TANK GAUGING

Dependable remote reading tank contents gauges using a closed hydraulic transmission system. No power required.

Several sizes available. Approved by Underwriters Laboratories and Factory Mutual. UL approved switches.

Write for complete details, to Dept. E



Since 1920 LIQUIDOMETER INSTRUMENTS of proven quality

THE LIQUIDOMETER CORP.
LONG ISLAND CITY 1, NEW YORK

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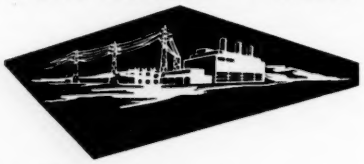
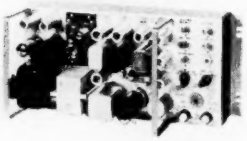
For more information circle **72** on inquiry card.

Telemeter
ANY VARIABLE from Remote Points





MODEL 1025 Transmitter

MODEL 1090 Receiver

Accurate, Fast Acting, Frequency Type Telemeter for Transmission over Wire Lines, Microwave, and Power Line Carrier

Accurate HIGH-SPEED Continuous Telemeter for VOLTS AMPS WATTS VARS ETC.

Built-in Self-Calibrating Circuit

The Model 1025 Telemeter Transmitter converts DC mv from thermal converters, etc., to 10-30 cps which frequency modulates a built-in audio tone channel. AC 10 to 30 cps or relay outputs are also available. Receiver detects and demodulates transmitted signal, generating a DC mv for operation of recorders or indicating instruments. Up to 45 telemeters can be multiplexed.

Any communication link, including power line carrier, microwave or wire line may be used.

Over-all accuracy is 1% with a response speed of 1 second. Equipment features a built-in calibration circuit for 10% and 90% receiver check, and 10 cps and 30 cps transmitter check.

Any quantity which may be converted into a DC millivoltage or will operate a slidewire may be telemetered.

WE CAN HELP YOU
Our Applications Department is ready to assist you in your control, telemetering or communications problem. Phone DEerfield 4-3100.

Write for Technical and Application Data.

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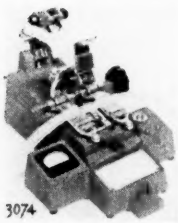
LABORATORIES, INC.
Boonton, New Jersey, U. S. A.

For more information circle **74** on inquiry card.

MAG-TAPE SPLICER

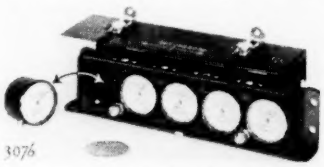


New Model 300.1 combination butt weld splicer and overlap splicer for any type of magnetic material (mylar or acetate) will handle any width up to 2¾"; has an overlap splice which is flat on oxide side.—*Prestoseal Mfg. Corp.*, 37-27 *33rd St., Long Island City* 1, *N. Y.*

For more information circle **232** on inquiry card.

ACCELERATION RECORDER

New watchlike Recording Accelerometer weighs 2 oz, registers accelerations exceeding set point within



its range. A typical unit with 2-12-*G* range has a maximum counting rate of 15 counts per second, natural frequency 25 cps and damping 0.7 of critical. (Instruments are also offered with higher or lower ranges and different response characteristics.) Sensitive axis is parallel to 12 o'clock pointer position. Count capacity is 3600. Photo shows a typical five-instrument mounting. With each accelerometer set for a different response level, it reveals range and distribution of accelerations encountered by the aircraft, vehicle, shipment, etc.—*Research, Inc.*, 115 *N. Buchanan St., Hopkins, Minn.*

For more information circle **233** on inquiry card.

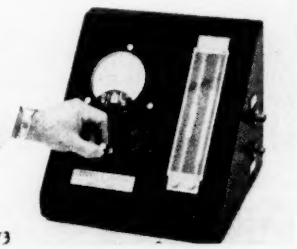
OSCILLOGRAPHS

New Series 350 direct-writing oscillographic recording systems provide (1) greatly reduced size, being complete 6- or 8-channel systems packaged in a single mobile vertical cabinet; (2) improved performance: frequency response flat to 100 cps at 10-division peak-to-peak amplitude and 3 db down at 120 cps, linearity 0.2 div over entire 50 div, hysteresis level less than 0.2 div; (3) interchangeable plug-in preamplifiers with individual power supplies; (4) pushbutton control of nine chart speeds from 0.25 to 100 mm/sec; (5) connections for remote control of recorder.—*Sanborn Co., Industrial Div.*, 175 *Wyman St., Waltham* 54, *Mass.*

For more information circle **234** on inquiry card.

GAS AND VAPOR FLOW METER

New Micro-Flow Meter measures, calibrates and flow-sets low flows of gases and vapors (both corrosive and



non-corrosive). It measures flows as low as 1 cc/hr and up to 10 cc/min or higher. Its precision-formed micro-flow channel produces a low-level differential pressure, and a sensitive differential pressure gage provides flow indication. Also available: versions which provide a dc or ac signal suitable for standard recorders and controllers. Range changing is accomplished by replacing micro-flow channel tube.—*George K. Porter Inc., Flow Meter Div., Hatfield, Pa.*

For more information circle **235** on inquiry card.

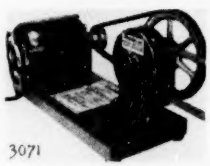
COUNT RATE METER

New N-701B Logarithmic Count Rate Meter has a maximum-count limit switch that can be used to acti-

vate an alarm system. Four ranges: 1-1000, 10-10,000, 100-100,000, and 1-100,000 cps; output 1-10 mv for recorder.—*Hamner Electronics Co., Inc., P. O. Box* 531, *Princeton, N. J.*

For more information circle **236** on inquiry card.

PERISTALTIC PUMP



New Randolph Pump features no-contact between moving parts and fluid being pumped. One flexible tube passes through pump body where it is acted upon by kneading action of a double rotor. Unit can handle any solution for which there is flexible tubing of suitable chemical and wear resistance.—*Palo Laboratory Supplies, Inc.*, 81 *Reade St., New York* 7, *N. Y.*

For more information circle **237** on inquiry card.

ANOTHER BROOKS ROTAMETER first

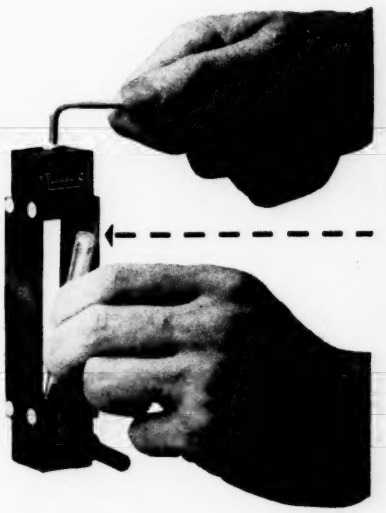
"SLIP-OUT" Metering Tubes simplify flow measurement

Thousands of installations since 1953 prove the practical simplicity of the Brooks "Slip-Out" metering tube.

Just a turn of the sealing plug permits the tube to be lifted out . . . for quick cleaning or an instant change in flow range. O-ring seals eliminate stuffing boxes . . . reduce possibility of breakage.

Available in low-flow purge flow meters and larger sizes to 2".

Write for Bulletin 120.



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958-I STREET
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For more information circle **75** on inquiry card.

HEATING PROCESS?

PROTECT

MATERIAL and EQUIPMENT

Automatically

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Not expensive... but a simple, automatic way to safeguard your investment in heating equipment and materials in process.

The precision-built Pyrotac constantly indicates temperature of the heated equipment and sounds an alarm and/or shuts down the equipment at a safe, preset temperature. May also be used as a controller on processes where shutdown is required upon reaching final process temperature—such as ceramic kilns, molds, etc. Automatic thermocouple break protection assures complete safety if couple or lead wire should break.

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For more information circle **76** on inquiry card.

PANEL SPACE LIMITED? SPECIFY

DIALCO® 2-Terminal

Sub-Miniature Pilot Lights

COMPACT
RUGGED
OMNIDIRECTIONAL PLASTIC DOMES
COMPLETELY INSULATED

Also available with "Taper-Tab" quick-connect terminals

BACK of panel insertion

or **FRONT** of panel insertion

△ Dimming and ◁ Non-dimming types

Also

1-Terminal Pilot Lights

for use on grounded circuits. Available with *binding screw* or *soldering* terminal.

DIALCO's expanded line of sub-miniature lights conform to all applicable Mil Specs. Use T-1¾ midget incandescent lamps—1.3 to 28 V. Spring mounted *Lens-with-Message* is readily positioned *after* installation... Mount from *back* of panel in 15/32" clearance hole; or from *front* of panel in 17/32" hole... 7 lens colors... Shown approx. actual size (top to bottom): No. 134-3830-375-6... No. 101-3830-951... No. 101-5030-951... No. 109-3830-111... No. 111-3830-111... No. 107-1930-951.

Complete details in Brochures L-156 A and L-157.

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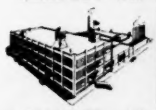

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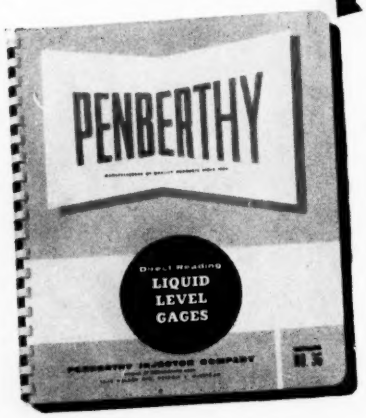
Name _____ Position _____

Company _____

Address _____

For more information circle **77** on inquiry card.

GET THIS HANDY GUIDE TO BETTER VALVES AND GAGES



Shows complete line of Penberthy valves and liquid-level gages for power, petroleum, and process industries. Includes technical data, parts, price lists, and accessories such as:

HEATING AND COOLING GAGES... for accurate readings where liquids must be cooled or heated to obtain exact measurement.

INSTRUMENT VALVE... permits gage repair or replacement without shutdowns. Back-seating stem permits repacking under pressure.

FROST PREVENTIVE GAGE... eliminates frost build-up... assures dependable visibility. For industries where frosting interferes with accurate readings.

ILLUMINATORS . . . plastic wedge distributes bright, even light along entire column. Nonglaring... dustproof for perfect illumination.

WELDING PAD GAGES . . . where process conditions require observation windows as integral part of vessel.

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Please send FREE copy of Catalog #36.

NAME_____ TITLE_____

ADDRESS_____

COMPANY_____

For more information circle **78** on inquiry card.

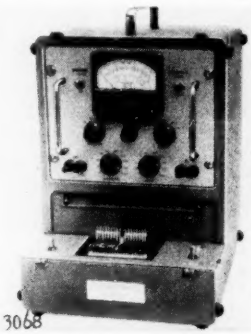
PRESSURE REGULATORS

New Series 20AP water pressure regulators feature protection against corrosion; are available in pipe sizes from ¼" through 1" and in 0-50, 0-125, 0-250 psi ranges. Each is suitable for line pressures up to 400 psi and temperatures up to 200°F.—*C. A. Norgren Co., Englewood, Colo.*

For more information circle **238** on inquiry card.

GALVANOMETER ANALYZER

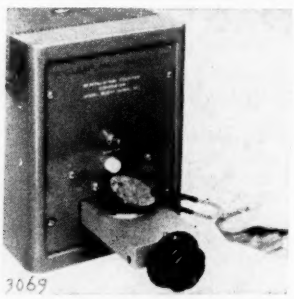
New GA-101 allows a complete check of all mirror galvanometer parameters, including damping, frequency response, static balance and dc sensitivity, replacing complex test equipment. Its optical system permits maker's rating to be checked directly. Temperature-controlled magnet block, with dummy galvanometers in all unused channels, duplicates operating conditions.—*North Atlantic Industries, Inc., 603 Main St., Westbury, N. Y.*



For more information circle **239** on inquiry card.

ALPHA COUNTING CONVERTER

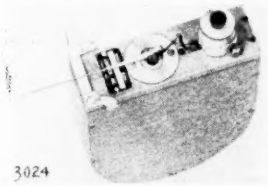
New Model SCC-11 alpha scintillation counter converter, only instrument of its kind now on market, converts any scaler into an alpha counting system; plugs into any make or model scaler; can be decontaminated and placed back in use within 5 min. —*Nuclear Measurements Corp., 2460 N. Arlington Ave., Indianapolis 18, Ind.*



For more information circle **240** on inquiry card.

RECORDER GALVANOMETER

New high-frequency ink-writing oscillograph galvanometer for general use with transistor-powered amplifiers uses a d'Arsonval armature in the field of an Alnico V magnet; features flat frequency response from dc to 35 cps and extended flat response up to 200 cps with compensated signal amplification. Standard 3" pen can be driven 1 cm by 16.5 ma, or 4.025 v across outside coil terminals.—*Edin Co., 207 Main St., Worcester 8, Mass.*



For more information circle **241** on inquiry card.

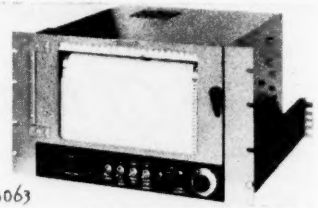
VISUAL TRAINING AID

New VTVM Dynamic Demonstrator helps instructors teach operation of a vacuum-tube voltmeter by simulating maker's No. 221 VTVM in all its functions and ranges. Giant (13") scale makes for easy classroom viewing. Demonstrator can be placed atop desk and has punched holes for wall mounting.—*EICO, 33-00 Northern Blvd., Long Island City 1, N. Y.*

For more information circle **242** on inquiry card.

STRIP-CHART RECORDER

New 10"-chart transistorized Model 80, designed especially for lab use, provides push-button chart-speed selection (1 iph to 1 ips), multiple-range span controls, and remote control facilities. Entire chart transport can be drawn forward to fully-exposed position. All controls are on panel immediately below chart mechanism: no interference with chart observation. Spans available in various combinations from 1 mv to 500 volts; scale can be zero center or zero left. Sensitivity 0.1% of span; 0.05% dead zone. Pen speeds to ¼ second for full-scale travel.—*F. L. Moseley Co., 409 N. Fair Oaks Ave., Pasadena, Calif.*



For more information circle **243** on inquiry card.

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* the ONLY SINGLE UNIT that delivers "Instrument-Quality Air"

- MAXIMUM CONDENSATION
  Air is cooled to within 2° of cooling water
- DISPOSABLE FILTER CARTRIDGE
  Removes dirt, sludge, oil and other foreign matter
- RUGGED CONSTRUCTION
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  Needs only 1 HOUR PER YEAR servicing
- RATED CAPACITY
  100 scfm at 100 psig

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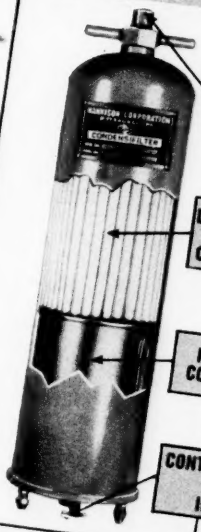

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For more information circle 79 on inquiry card.

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5" Diameter Brass Case
in Black Finish

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For more information circle 81 on inquiry card.

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*CORNING 707
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FERRITE
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GERMANIUM
INDIUM ANTIMONITE
INDOX
MELAMINE FIBER GLASS
MICA, SYNTHETIC
POTASSIUM BROMIDE
*PYREX
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*Carried in stock
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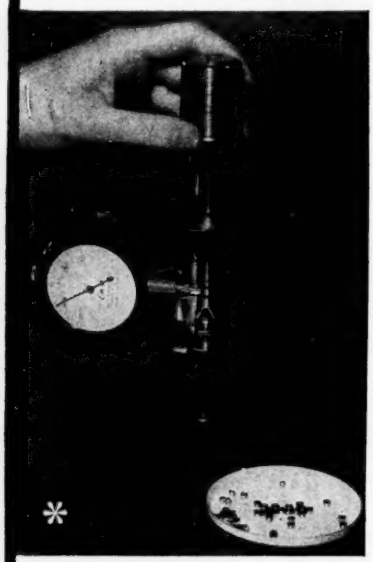
For more information circle 80 on inquiry card.

There's a *Bird*
JEWEL BEARING
to fit Your Need!



Bird can supply you with sapphire and borrosilicate glass precision jewel bearings in a wide range of standard types, sizes, and complete assemblies — or, custom-built to your specifications. Special mounting techniques provide exact tolerance jewel assemblies, mounted or set in bushings or screws, ready for assembling into your product without further inspection. Jewels mounted with resilient silicone rubber or spring cushions provide additional protection to shock and vibration.

Because of the exact tolerances, maintained through the most rigid quality-control methods, Bird jewels are used by the foremost manufacturers of electrical, aircraft, and timing instruments — and recorders.

Typical products include:

Aircraft Instruments
Weather Recorders
Ammeters
Voltmeters
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Marine Instruments

**Illustrated — Concentricity check of mounted ring jewels — one of the inspection processes in Bird's quality control program.*

Our engineering staff is at your service for all small bearing problems. A request on your letterhead for Bulletin 100-6 will receive our prompt attention.

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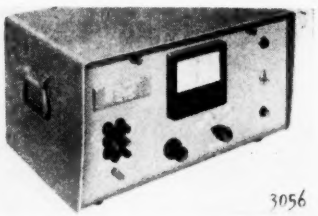
SAPPHIRE & GLASS JEWELS
PRECISION GLASS GRINDING
JEWEL MOUNTING & ASSEMBLY

For more information circle **82** on inquiry card.

IMPEDANCE COMPARATOR

New Model 343 Impedance Comparator features extreme stability accomplished by use of constant-volt-

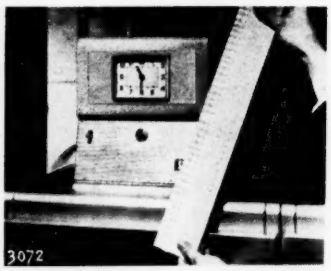


age transformer for regulated filaments, electronically series regulated B supply, and voltage regulator tubes. Its 14-tube circuit gives 0.05% accuracy over wide range of impedance (10 ohms to 15 megohms) without adjustments. Range switch for 1%, 5%, 10% and 20% full-scale ranges. —*Inland Electronics Corp., 500 Rathbone Ave., Aurora, Ill.*

For more information circle **244** on inquiry card.

RECORDING ANNUNCIATOR

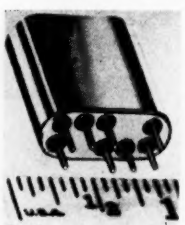
New Recording Annunciator is basically a clock-printer and relay unit which monitors 8 to 32 points



per operational system (larger units available to monitor up to several thousand points). It records, to the second, the time any part of system goes off-normal and the time it returns to normal. Tape is advanced only after a printing, eliminating useless accumulations.—*Panalarm Div., Panellit, Inc., 2401 N. Hamlin, Skokie, Ill.*

For more information circle **245** on inquiry card.

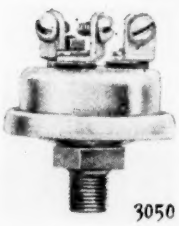
"CRYSTAL-CAN" RELAY



New BR8 utilizes a novel contact configuration for maximal overtravel and ample wipe; exceeds applicable MIL specs for subminiature "crystal can" relays: 30 *G*, 10-2000 cps, operate and release <5 ms, pull-in power 200 mw for dp-dt and 80 mw for sp-dt relays. —*Babcock Relays, Inc., 1640 Monrovia Ave., P. O. Box 344, Costa Mesa, Calif.*

For more information circle **246** on inquiry card.

DUAL PRESSURE SWITCHES



New dual-circuit pressure switches for dc use are available in three ranges: 3-6, 7-14, 15-60 psi; are preset at factory, user having specified actuating pressure. Among uses: flashing red and green lights, locking out starting motor while engine is running, etc.—*John W. Hobbs Corp., Yale Blvd. and Ash St., Springfield, Ill.*

For more information circle **247** on inquiry card.

GAS ANALYZERS

New Therma Bridge Gas Analysis Equipment line includes (1) Therma Bridge Gas Analyzer for monitoring

gas stream purity and for general thermal-conductivity applications; (2) Therma Bridge Stabilized Temperature Sensing Unit for measuring low impurity percentages in both straight gas analysis and gas chromatography and also for thermal conductivity measurements at elevated temperatures; (3) Therma Bridge transistor-regulater Power Supply and Control Unit available as power source for any thermal conductivity cell; (4) Therma Bridge Sensing Cells available in heavyweight open-core hexagonal unit, and in light-walled individual-cavity type, both available with either hot-wire tungsten or thermistor sensing elements. Entire line is housed in functionally designed cabinetry with all gas and electrical controls located in convenient operating positions.—*Industrial Instruments Engineering Corp., 89 Commerce Rd., Cedar Grove, N. J.*

For more information circle **248** on inquiry card.

HI-TEMP PRESSURE PICKUP

New high-temperature version of versatile Model 45176, for use in ambient temperatures up to 149°C (300°F), is available in ranges from 0-5 to 0.150 psia, psig or psid with resolution up to 450 wires (0.22%) in higher resistance ranges.—*G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena 1, Calif.*

For more information circle **249** on inquiry card.

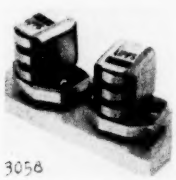
SOLENOID VALVES

New Series J low-cost line of solenoid valves control non-corrosive fluids to maximum operating pressure differential of 150 psi; can be mounted in any position; utilize pilot port operating principle; have synthetic diaphragms successfully operated through millions of test cycles with little or no wear.—*Jackes-Evans Mfg. Co., Controls Div., 4427 Geraldine Ave., St. Louis 15, Mo.*

3057

For more information circle **250** on inquiry card.

RECORD AND PLAYBACK HEAD



New Model 303 twin-3-channel record and playback magnetic head, for 35-mm film or 1" tape instrument recording systems, features precision lapped heads with 0.002" gap for recording half and 0.0005" gap for playback half; and dimensionally-stable epoxy resin providing continuous moisture-proof operation from −55°C to 175°C and >1000-hr operating life.—*Lipps Engineering, 1511 Colorado Ave., Santa Monica, Calif.*

3058

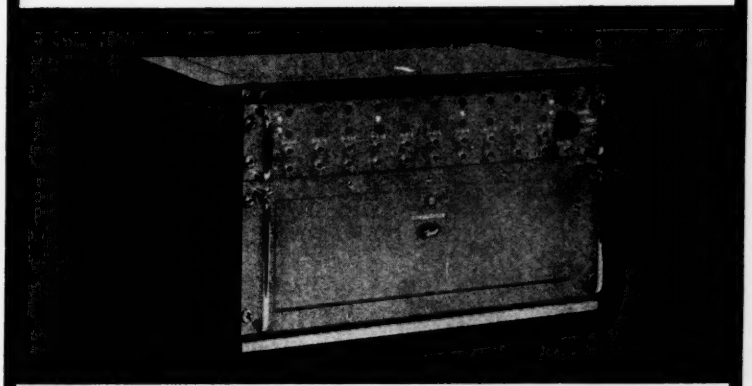
For more information circle **251** on inquiry card.

HOOK-ON RECORDING V-A

New CH-7 hook-on recording volt-ammeter combines butyl-molded hook-on tranformer of CF-7 with fast response time and numerous chart drives of CH recorder; features direct-writing ink system, and accuracy within 2%. Six current ranges from 15 to 750 amp and three voltage ranges from 150 to 750 for 60-cps ac. Chart is 150 ft long, 6" wide with 4½" scale marked 0-15.—*General Electric Co., Schenectady 5, N. Y.*

For more information circle **252** on inquiry card.

30,000 samples per second *



* *300 samples per second for each of 100 inputs*

Wherever a large number of transducer signals must be sampled for high-speed recording, the Wiancko High-Speed Commutator can give unrivalled performance. It will accept up to 100 low-level ac or dc inputs and sample at up to 30,000 samples per second. It will maintain this pace over trillions of faithful cycles of operation because it uses solid-state elements exclusively, requiring only 8 watts of power.

The High-Speed Commutator is adaptable to a great variety of FM telemetering systems, AM systems, logging systems, and dc data systems. The commutated output is directly applicable to any high-speed analog-to-digital converter. The commutator's clock-pulse generator can be used to synchronize the converter with the commutator. In many applications no amplifiers are needed since inputs as low as ±50 millivolts full scale can be commutated directly.

For more detailed information, write for Product Bulletin 103.

Wiancko Engineering Company
255 N. Halstead Avenue • Pasadena, California

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For more information circle **83** on inquiry card.

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Front Surface Mirrors, Cold Mirrors, Achromatic Beam Splitters, Dichroic Beam Splitters, Monochromatic Interference Filters, Wedge Interference Filters, Heat-Reflecting Interference Filters, Cut-Off Filters, Anti-Reflection Coatings, Heat Protective Coatings and many other thin layers.

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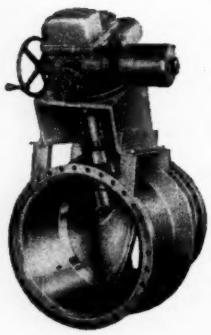
Balzers means research in high vacuum process

For more information circle **84** on inquiry card.

Your plant needs

ROCKWELL VALVES *like these*

"Kwikleen" slide valve for powdered coal, granular materials, flue gases with high solids content, etc.; solids accumulations easily cleaned out by removing bottom plate.



"Stress-seal" butterfly valve for tight shut-off of hot, corrosive or dirty gases to 1300° F. and higher, at 200 p.s.i. Alloy stress band in valve body is inflated by external gas pressure to effect tight seal.

Butterfly valve with simplified bracket and linkage to air operator and valve disc positioner; provides maximum adjustment, minimizes friction, eliminates backlash, chatter and hunting, reduces power requirement in close control applications.

"Slim-Jim" wafer type butterfly valve for low pressure air, gas or liquids; low cost, light, simple, space-saving, easy to install.

What's your valve problem?

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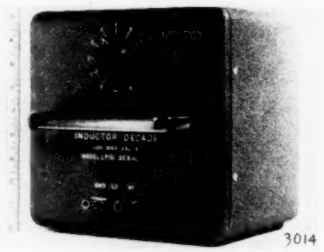
FAIRFIELD, CONN.

For more information circle **85** on inquiry card.

INDUCTANCE DECADES

New Models LP 121, LP 131 and LP 141 are high-*Q* low frequency decade inductors with micrometer adjustment that permits precise settings. Designed for exacting analog computer and lab applications, they have maximum values of storage factor *Q* in excess of 300; are available in three decades (0.01-0.1, 0.1-1, and 1-10 henries) which can be combined to permit switching-in any value of inductance from 0.01 to 11.1 h in 0.01-h steps. Dc resistance (full winding) is 2.25 ohm/henry maximum.—*Computer Engineering Associates, Inc., 350 N. Halstead Ave., Pasadena, Calif.*



3014

For more information circle **253** on inquiry card.

VACUUM CONTROLLER

New Type TC automatic controller is commanded by a thermocouple type gage for electrically controlling vacuum or process equipment within the range from 500 microns down to 5 microns. Relays are available with n-o or n-c contacts. Red and green pilot lights indicate relay contact position.—*Veeco Vacuum Corp., 86-P Denton Ave., New Hyde Park, L. I., N.Y.*

3093

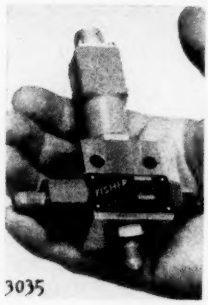
For more information circle **254** on inquiry card.

TWT AMPLIFIER

New MAS-1A is an S-band periodically-focused travelling-wave tube amplifier with 1-kw power output over a frequency band of 2000 to 4000 Mc. Peak power outputs are obtained with duty cycles up to 0.005 when operated with 1-watt drive. Gain of 30 to 33 db gives >1 kw over most of band. Permanent-magnet focusing field eliminates solenoid, solenoid power supplies, and solenoid heat dissipation.—*Hughes Products, International Airport Station, Los Angeles 45, Calif.*

For more information circle **255** on inquiry card.

D/P SWITCH

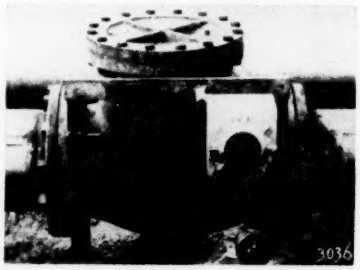

3035

New differential pressure switch will measure d/p from 10 to 2000 psi in a system up to 5000 psi; is unaffected by vibration or jarring. Differential is externally adjustable. Standard units weigh 6 oz, will operate from —65°F to 165°F; are rated 15 amp @ 120 vac.—*Fisher Controls Inc., 1928 Lincoln Blvd., Santa Monica, Calif.*

For more information circle **256** on inquiry card.

AUTOMATIC FLOW CONTROL

New Flow-Actuated Control automatically starts and stops pumps supplying a liquid product, as demand increases or decreases. Typical application: tank-truck loading. Before first pump reaches its full capacity output, unit starts second pump; as first and second pumps reach their full-capacity output, second and third are started, and so on. As demand decreases, reverse sequence takes place.—*Flow-Actuated Control Co., Inc., 101 W. Palisade Ave., Englewood, N. J.*


3036

For more information circle **257** on inquiry card.

FLOW-CONTROL VALVE

New in-line pressure-compensated flow regulator is adjusted for desired flow-rate by rotating calibrated valve sleeve. Built-in check valve provides free flow in non-compensated direction. Available in ¼", ⅜" and ½" pipe sizes for flow rates to 5, 10 and 18 gpm. Maximum operating pressure 3000 psi. Immediate delivery.—*Fluid Power Accessories, Inc., P. O. Box 64, Glenview, Ill.*

3037

For more information circle **258** on inquiry card.

When the design calls for an indicating gauge, specify the best—
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New catalog covers gauges for every need
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For more information circle **86** on inquiry card.

Automatic Control Technology, Modern Theory and their Usefulness

483 + XV pages, 1957, 898 illustrations and 48 tables. Includes 90 advanced papers on control technology, as delivered in original language (English, French, German, Russian; all Russian papers are translated into German; about ½ of book is in English). 9" x 12". Handsome cloth binding. Printed by R. Oldenbourg Verlag, Munich, Germany.

The book is a report of the Heidelberg Meeting, September 25 to 29, 1956, arranged by the VDI/VDE-Fachgruppe Regelungstechnik with the cooperation of the Fachausschuss Regelungsmathematik der Gesellschaft fuer angewandte Mathematik and Mechanik (GAMM); edited by Gerd Mueller for VDI/VDE-Fachgruppe Regelungstechnik.

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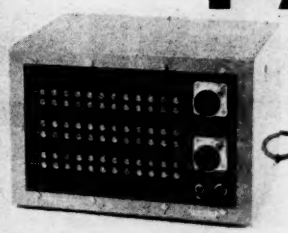

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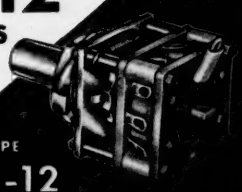
For more information circle **87** on inquiry card.

***NEW* miniature rotary switch**

TYPE MA-12

12 POSITIONS
5 SECTIONS
3 AMP.
115 V.
A-C



FEATURES:

- **Small** — ¾" square
- **Versatile** — up to 6 poles per section; up to 5 sections
- **Current-carrying capacity** — 3 amp.
- **Interrupting rating** — ½ amp. 115 v. a-c.
- **Voltage breakdown** — 1000 volts RMS
- **Rotation** — unlimited, or limited 2 to 12 pos.
- **Electrical life** — 10,000 cycles at rated load
- Designed to meet MIL-S-3786

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For more information circle **88** on inquiry card.

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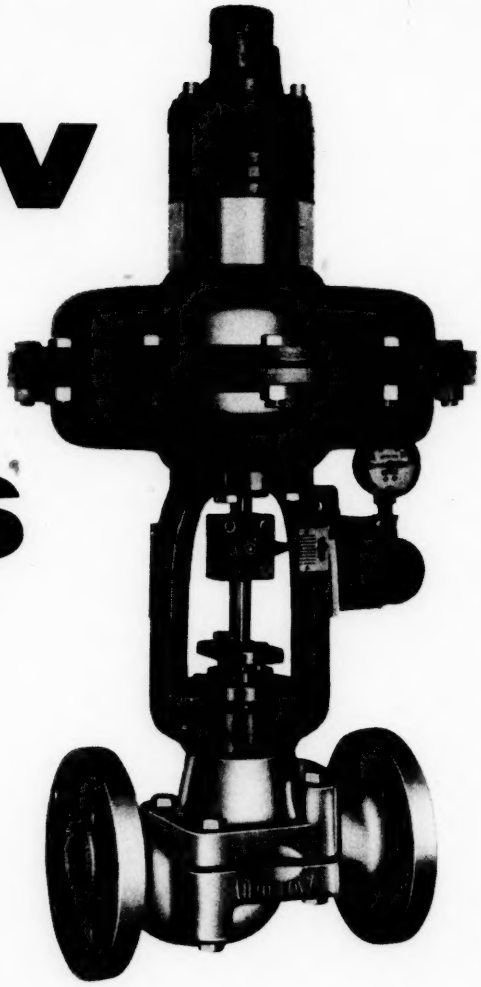
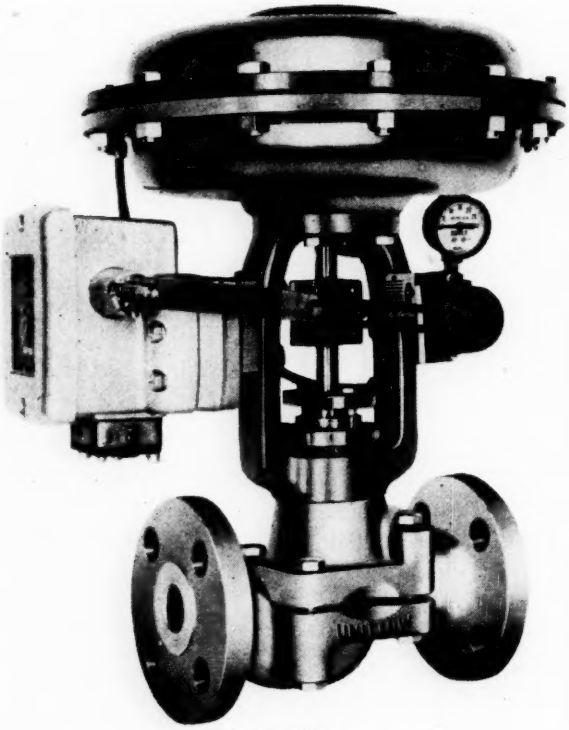
AIR OPERATED CONTROL
Valves





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- HIGH Cv
- SUPER POWER DIAPHRAGM MOTOR

UNIFLOW VALVE CORPORATION

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For more information circle **144** on inquiry card.

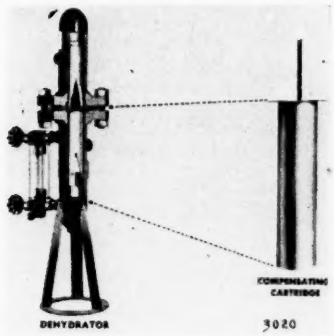
PHOTOELECTRIC TACHOMETER

New DY-2504A permits measuring shaft rotational speeds or accumulated turns accurately on electronic counters; can also be used to measure transient rotational phenomena on an oscilloscope. It features low running torque and inertia, constant output voltage regardless of rotational speed, and up to 1° resolution; can be turned in either direction, at speeds from 0 to 10,000 rpm. Choice of 60, 100, 120, 180, 200 or 360 pulses per revolution. Operating power 6.3 vac @ 150 ma.—*Dynac, Inc.*, 395 *Page Mill Rd., Palo Alto, Calif.*

For more information circle **259** on inquiry card.

LOW-COST DEHYDRATOR

New dehydration units, 2" to 8" diameter, make possible, economically, dew points of −150°F and 5-



micron filtration of air, gases or liquids; eliminate freezing and corroding in instruments, valves, etc.; remove 1 lb of water for "as little as 7 cents where former costs ranged from $2.50 to $3.75."—*Dehydrators, Inc., P. O. Box 7359, Tulsa, Okla.*

For more information circle **260** on inquiry card.

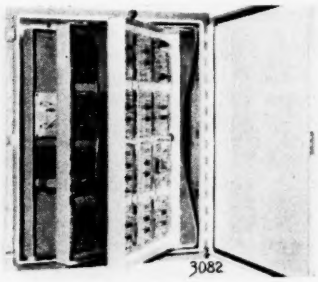
MINIATURE WIREWOUND VDR

New No. 200L-2-104 Trimpot screw-actuated voltage-dividing resistor with a resistance range to 100,000 ohms features improved design which provides a large winding volume in a miniature unit measuring ¼" x ⅜" x ¼". Precision windings are made on a ceramic card and terminated by exclusive Silverweld technique which offers unusual stability as well as zero end settings. New unit has 25 turns of screw for adjustment accuracy; high stability; excellent shock and vibration characteristics; resolution 0.14%; rating ¼ watt at 70°C; maximum operating temperature 105°C.—*Bourns Labs., Inc., P. O. Box 2112, Riverside, Calif.*

For more information circle **261** on inquiry card.

TELEMETERING TRANSCEIVERS

New TTR Series pulse-code systems, for transmission and reception of digital information over telephone



lines, radio, or microwave links, provide output (without conversion equipment) for data handling, computing, printing, or supervisory control systems; are easily installed to control and monitor existing field equipment.—*Southwestern Industrial Electronics Co., 2831 S. Post Oak Rd., Houston, Texas.*

For more information circle **408** on inquiry card.

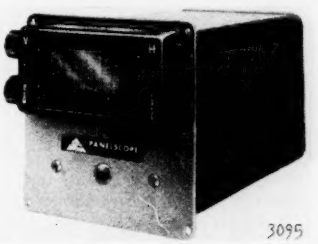
TELETYPEWRITER MONITOR

New Type CTM-1 Electronic Clear Text Monitor (being manufactured by Teletronics for Air Force as Model SSZ-5) is designed to prevent inadvertent clear text transmission of classified messages; will operate in either half or full duplex operation with any present on-line teletypewriter mixer.—*Teletronics Lab., Inc., 54 Kinkel St., Westbury, L. I., N. Y.*

For more information circle **409** on inquiry card.

TAPE MONITOR

New Model P-106-B Systemat multichannel tape monitor, with applications in telemetering, jet engine test-

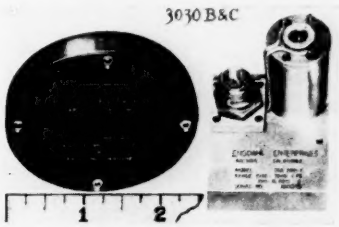


ing, etc., includes six Panelscopes mounted in a standard 19" rack panel. Power supply and sweep generator for up to 14 monitors is contained in an associated Panelpack. A single Panelscope control having two settings, permits quick calibration or normal operation. In calibrate position, 1" x 2½" rasters are displayed, indicating that system is in calibration and operating correctly. A system of lamps indicates under- or over-modulation.—*Waterman Products Co., Inc., 2445 Emerald St., Philadelphia 25, Pa.*

For more information circle **410** on inquiry card.

ACCELERATION RECORDERS

New Model 440 Multiple Recording Accelerometer, or Miniature Reed Gage (left) yields response spectrum



(peak acceleration versus frequency) of a structure subjected to high acceleration loads. It has eight sensing elements, each with a single degree of freedom along the same axis, each with a different natural frequency (total range 950-2000 cps). Unit can record from 100 to 10,000 *G*. ★ New Triaxial Recording Accelerometer (right) yields data for plotting acceleration versus time under extremely rigorous conditions; has three mutually perpendicular sensing elements so that the three plots can be added vectorially to give peak acceleration and direction in which it was acting. Unit will record from 250 to 10,000 *G*. Maximum dimension 2-⅛"; weight 6 oz.—*Engdahl Enterprises, Arcadia, Calif.*

For more information circle **411** on inquiry card.

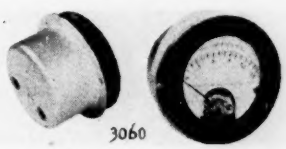
IGNITER CIRCUIT TESTER

New Model 101-5A is designed to safely and accurately preflight or production-check igniters used in solid-propellant rockets. Current through igniter under test cannot exceed 5 ma. Ranges 0-5 and 5-30 ohms.—*Allegany Instrument Co., Inc., 1091 Wills Mountain, Cumberland, Md.*

For more information circle **412** on inquiry card.

INSTRUMENT SHIELDS

New line of Netic Co-Netic magnetic shields will fit all shapes, aid miniaturization and increase reliabil-



ity, permitting unrestricted use of instruments in previously impossible locations.—*Magnetic Shields Div., Perfection Mica Co., 1322 N. Elston Ave., Chicago 22, Ill.*

For more information circle **413** on inquiry card.

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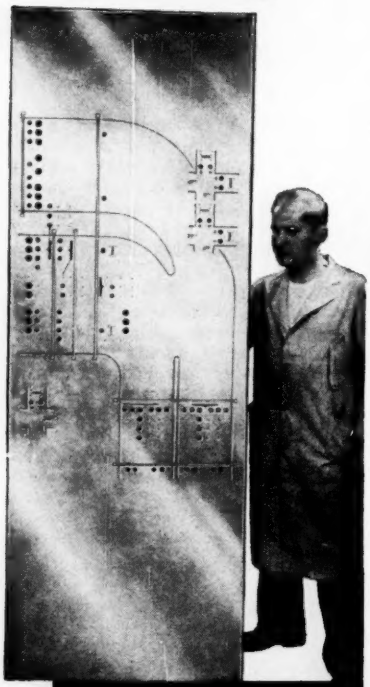
2138

NO panel too big



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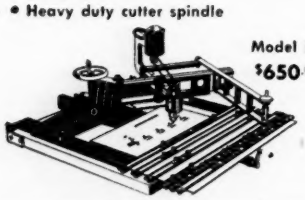

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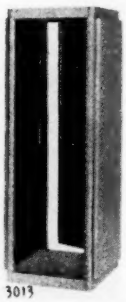
For more information circle **91** on inquiry card.

VHF MULTICOUPLER

New VHF Multicoupler, for ground or airborne operation, couples as many as five receivers to one antenna with minimum interaction and loss in sensitivity. Frequency range 90-200 Mc for maximal efficiency (50-200 Mc with reduced efficiency). Available with a plug-in preamplifier so that over-all gain from input to each output can be approximately unity. Made for rack mounting in ground applications and shock mounting in airborne applications.—*Westronics, Inc., RF Div., 3605 McCart St., Fort Worth, Texas.*

For more information circle **262** on inquiry card.

RACKS AND CABINETS



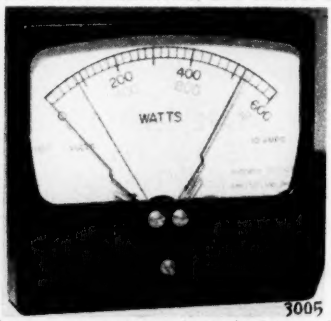
3013

New Prestige relay racks and Prestige Versa-Cabinets feature ball-cornered sides which are removable in seconds for easy access to components. Racks are available in three standard sizes and Versa-Cabinets in five sizes.—*Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio.*

For more information circle **263** on inquiry card.

CONTACT-TYPE WATTMETER

New locking-contact wattmeter is said to make possible for the first time direct monitoring and control of

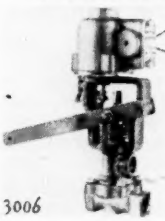


3005

electric power by a single instrument. High and/or low limits of wattage can be preset.—*Assembly Products, Inc., Chesterland, Ohio.*

For more information circle **264** on inquiry card.

3-WAY SOLENOID VALVE

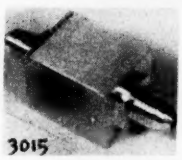


3006

New manual-reset 3-way solenoid valve is available in two types of operation: no-voltage release or electrically tripped; in ½", ¾" and 1" NPT, all standard voltages; general-purpose, watertight or explosion-proof solenoid enclosures.—*Automatic Switch Co., Florham Park, N. J.*

For more information circle **265** on inquiry card.

PRESSURE PICKUP



3015

New Model 1000 occupies one cubic inch, features continuity of output under the most severe vibration or shock, and accuracy said to "exceed that of any known potentiometer-type instrument." Precision carbon-film resistance element having virtually infinite resolution permits direct coupling of wiper to bellows. Non-linearity of bellows is nullified by resistance trimming after final assembly and while pressure-actuated. Pressure ranges 0-10 to 0-50 psi; resistance values to 10,000 ohms; hysteresis 0.1%; repeatability 0.1%; life >500,000 cycles; temperature sensitivity 0.01%/C°; acceleration sensitivity < 0.025%/G in any axis.—*Computer Instruments Corp., 92 Madison Ave., Hempstead, L. I., N. Y.*

For more information circle **266** on inquiry card.

URANIUM FLUORIMETER

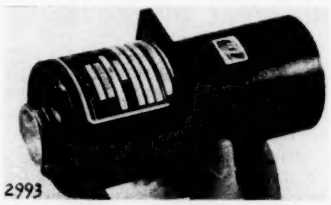
3007

New Model FL-500, believed to be "the first transmission-type fluorimeter to be offered as a commercial item", features range of 10^{-9} to 10^{-5} grams of uranium and, if care is observed in associated chemical process, can be used at levels below 10^{-9} gram. Operation is independent of normal power-line fluctuations. Digital readings minimize errors. Accessory for liquid samples permits determination of Be, Al, etc.—*Ball Bros. Research Corp., Box 191, Boulder, Colo.*

For more information circle **267** on inquiry card.

MULTICHANNEL TIMER

New fixed-position Interval Timer which limits contact bounce to < 300 usec on make and < 50 on break pro-



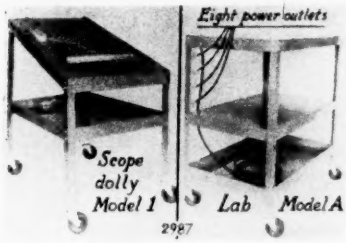
2993

vides timing cycles from one second to several hours. With up to five independent channels available in standard unit, events can be sequenced simultaneously or in a series, or in a combination of both. (Up to ten channels on special order, as the synchronous motor has ample torque.)—*Western Design & Mfg. Corp., Santa Barbara Airport, Goleta, Calif.*

For more information circle **268** on inquiry card.

DOLLIES

New dollies embody refinements and conveniences demanded by users, such as 3" rubber-tired ball-bearing



swivel casters.—*Technical Service Corp.*, 1404 *Market St., Louisville* 3, *Ky.*

For more information circle **269** on inquiry card.

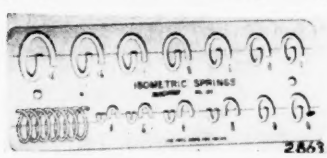
WIND SPEED AND DIRECTION INDICATOR

New Windscope is a remote-reading wind-speed-and-direction indicator, said to be "the only such instrument at a price less than $100 that indicates both wind direction and velocity on a single dial." It requires no auxiliary outside electricity: anemometer cups generate their own power and a 1½-v flashlight battery, installed in indicating panel, transmits signal from directional vane. Thus the only drain is when wind direction is being checked.—*Taylor Instrument Companies*, 95 *Ames St., Rochester, N. Y.*

For more information circle **270** on inquiry card.

SPRINGS TEMPLATE

New No. 126 helps depict helical springs in 13 OD's from 1¼" to ⅜".



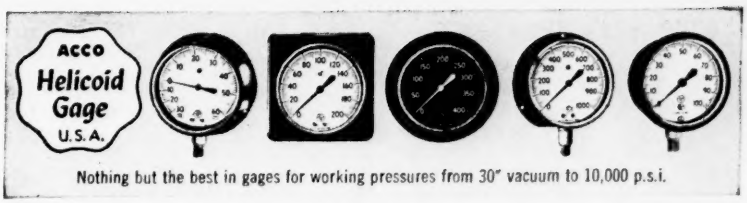
—*Rapidesign, Inc., P. O. Box* 429, *Burbank, Calif.*

For more information circle **271** on inquiry card.

DIGESTER CAPPING VALVE

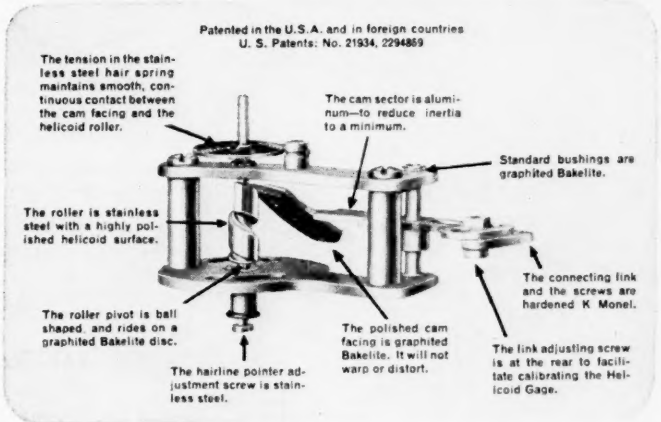
New remote-controlled stainless-steel Rovalve ends time-wasting and expensive manual removal of bolt-on type cap when loading digesters with chips, and rebolting for the "cook"; makes possible several extra cooks per day or week depending on chemicals and pulping process.—*Dept. IA* 35, *W. G. Rovang & Associates*, 1945 *N. Columbia Blvd., Portland* 17, *Oregon.*

For more information circle **272** on inquiry card.



Nothing but the best in gages for working pressures from 30" vacuum to 10,000 p.s.i.

These details of Helicoid gage design assure longer life and enduring accuracy


Patented in the U.S.A. and in foreign countries
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The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
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The *sustained accuracy* of Helicoid Gages over *millions of cycles* is explained by the details of design and construction of the Helicoid movement shown above. Such Helicoid features—protect against wear and corrosion and assure sensitivity, sustained accuracy and trouble-free operation.

The Chemical Gage

The Helicoid Chemical Gage has a guaranteed accuracy of plus or minus 1%. It is applicable for working pressures from 30" vacuum to 5000 p.s.i. and temperatures to 400° F. It is particularly suitable for chemicals and other viscous fluids which might clog or corrode a Bourdon tube. Pressure and/or vacuum is transmitted directly to the indicating gage element through deflection of a Teflon or Kel F sealing diaphragm.

Tubes built for millions of pressure pulsations

To fit the wide range of applications, Helicoid Bourdon tubes are available in four materials—alloy steel, K Monel, stainless steel and phosphor bronze.

All Helicoid tubes are made from seamless tubing and are carefully designed to give maximum torque and minimum stress. When used within the dial range, they will withstand many millions of pressure pulsations and will not stretch, leak or crack.

***For complete information on the Helicoid line of gages write for* Catalog G-52**

Helicoid gives you all these features at prices that are competitive in the quality gage field.

Helicoid Gage Division
AMERICAN CHAIN & CABLE
929-B Connecticut Avenue • Bridgeport 2, Connecticut

ACCO
TRADE MARK

For more information circle **92** on inquiry card.

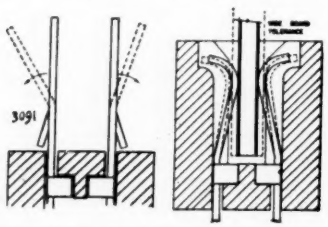
GYRO TEST TURNTABLE

New high-precision T-806, for testing low-drift gyros in either open or closed loop, features accurate tilting to permit polar axis drift tests as well as vertical, inverse-vertical and horizontal axis drift tests, all without changing position of gyro on turntable. Basic accuracy 2 seconds of arc. Total weight 900 lb. —*Sterling Precision Corp.*, 17 *Matinecock Ave., Port Washington, L. I., N. Y.*

For more information circle **414** on inquiry card.

PRINTED CARD RECEPTACLES

New versions of maker's printed card receptacles now embody positive electrical contacts. Changes are illus-



trated in drawings herewith.—*U. S. Components Inc.*, 454 *E. 148th St., New York* 55, *N. Y.*

For more information circle **415** on inquiry card.

SHAFT ROTATION CODER

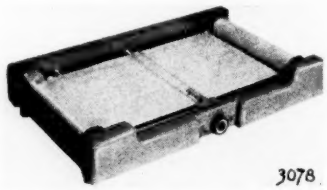
New Optisyn shaft angle indicator utilizes a novel principle: frictionless "optical gearing" whereby shaft

rotation input yields two output waveforms which contain all information necessary to measure total shaft angle. Two photodiodes are used in a current push-pull mode for each electrical waveform. Among advantages over usual single-ended circuit: balancing out of errors caused by fluctuations in light-supply or in photo-circuit-supply voltages, in photo diode characteristics; etc. Moreover, paramount problem of centering is solved by placing the two photodiodes of each circuit at diametrically opposite ends of the dial. By counting crossings of the two waveforms, digital logic can follow bi-directional motion of input shaft. Analog output of waveforms can also be used in either completely analog systems or hybrid analog-digital systems.—*Dynamics Research Corp.*, 44 *Winn St., Woburn, Mass.*

For more information circle **416** on inquiry card.

CHART VIEWER

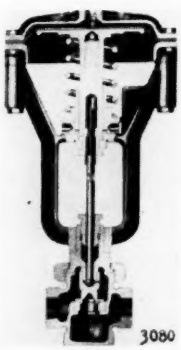
New Model 276 oscillographic recording chart viewer provides variable chart drive speeds from 15 to



1200 ipm; accepts charts up to 16" wide and 200 ft long; allows rewinding at any time, prevents supply-roll overrun when speed is reduced.—*Sanborn Co., Industrial Div.*, 175 *Wyman St., Waltham* 54, *Mass.*

For more information circle **417** on inquiry card.

BMV CONTROL VALVES



New complete line of diaphragm-operated instrument-commanded valves features exclusive V-port design said to afford extremely precise modulation of flow because of tapered variable port area. Sizes 1/16" to 2" NPT (direct-acting) and ⅛" to 2" NPT (reverse-acting). Instrument air 2.5 to 12 psi for direct-acting valves, 4 to 13 psi for reverse-acting. Spring tension is adjustable. Pressure limit 250 psi.—*Sinclair-Collins Valve Co.*, 454 *Morgan Ave., Akron* 11, *Ohio.*

For more information circle **418** on inquiry card.

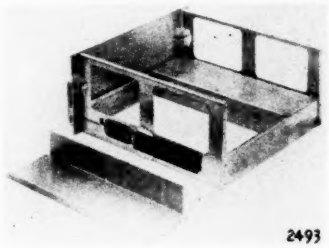
LINE VOLTAGE REGULATOR

New Model 2501 2500-vac voltage regulator with 0.01% accuracy is recommended for use in standards laboratories, for instrument calibration, etc. Input voltage 95-130 at 55-65 cps; output voltage adjustable 110-120; 3% maximum distortion; power factor from unity to 0.7 lagging; time constant 0.2 sec.—*Sorensen & Co., Inc., Richards Ave., South Norwalk, Conn.*

For more information circle **419** on inquiry card.

UNIVERSAL CHASSIS

New series of universal chassis emphasizes rigidity and versatility. Modular models (photo) are available



with multiple subchassis units to facilitate fore-and-aft or cross mounting and superior cooling of assemblies. Customer may specify all dimensions, material and finish. Fast delivery.—*Western Devices, Inc.*, 600 *W. Florence Ave., Inglewood, Calif.*

For more information circle **273** on inquiry card.

SAMPLE-CASE SAMPLE

New sample case is not only a container but a working example of maker's deep-drawn metal products; is

finished in baked enamel typical of maker's paint shop.—*Zero Mfg. Co., Burbank, Calif.*

For more information circle **274** on inquiry card.

WRAP-AROUND TAPE

New "stretch" vinyl compound, of greater elasticity than ever before, now used in General Purpose Zipper-

tubing, doubles pull strength at closure point. Another improvement in Zippertubing general-purpose compound is embossment of one side, providing for a tighter grip on wires and cables by jacket, and aiding immediate fabrication of cables on the spot.—*The Zippertubing Co.*, 752 *S. San Pedro St., Los Angeles* 14, *Calif.*

For more information circle **275** on inquiry card.

3-WAY FOCUSING CAMERA

New Alpa 8, Swiss single-lens reflex camera priced under $500, offers unique choice of three focusing systems: (1) single-lens reflex system for parallax-free focusing, ease of composition and depth-of-field control; (2) split-image prism rangefinder for pinpoint focusing; (3) superposed rangefinder combined with Sportstype multifocal viewfinder.—*Karl Heitz, Inc., 480 Lexington Ave., New York 17, N. Y.*

For more information circle **276** on inquiry card.

MULTIPLIER PHOTOTUBE

New 9-stage RCA-7200 multiplier phototube, designed especially for detection and measurement of ultraviolet radiation, and for other applications involving low-level radiation sources, employs an envelope consisting of a fused-silica section and a graded-seal section. Its spectral response covers range from about 1800 to 6000 angstroms, maximal response at about 3300 angstroms. It has negligible sensitivity to red radiation.—*RCA Industrial Tube Products Dep't, Harrison, N. J.*

For more information circle **277** on inquiry card.

LEVER-ACTUATED SWITCH

New waterproof switch, designed for short-cycle operations such as spot welding, can be made with either

n-o or n-c contacts; has lever enclosed in a silicone boot that protects mechanism from water, dust, etc.; full-width lengthwise V-groove on back for attaching to supports such as rods.—*Control Products, Inc., 306 Sussex St., Harrison, N. J.*

For more information circle **278** on inquiry card.

FOOT OR ELBOW SWITCH

New foot, knee or elbow switch permits hand-free actuation of electric devices. Foot operation requires

4-lb force with ¼" pedal travel. For knee or elbow operation, removal of a spring affords light-pressure actuation.—*Production Instruments Div., General Controls Co., 8062B McCormick Blvd., Skokie, Ill.*

For more information circle **279** on inquiry card.

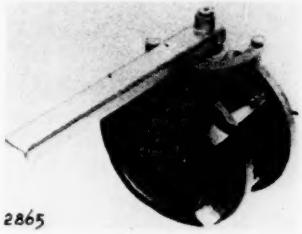
GLASS-CASED TRANSISTORS

New glass housing for transistors is the first which meets TO-9 outline dimension standard for low-power signal transistors recommended by JETEC (composed of representatives of both EIA and NEMA). Makers state that material costs alone could be reduced to as little as one-tenth those for many metal cases; and that glass lends itself much more readily to inexpensive high-volume mechanization without sacrificing reliability.—*G. E. Semiconductor Products Dept., Syracuse, N. Y.*

For more information circle **280** on inquiry card.

VALVE POSITION HOLDER

New Automatic Irreversible Control assures positive holding of butterfly valves under extreme pressure at



an infinite number of settings; can withstand up to 1000 pound-inches torque. To unlock for new settings, brake shoes (held apart by spring) are moved together slightly—by hand, by solenoid, by hydraulic actuator or by motor. Minute movements can be made for inching.—*Reid Metal Products, Inc., 2021 N. Lincoln St., Burbank, Calif.*

For more information circle **281** on inquiry card.

SMALL REVERSIBLE MOTOR

New Type 11A-8011-01 versatile Size 11 airborne-quality instrument-type synchronous reversible motor weighs 4¼ oz, is rated at 12 watts input; can be connected to 60- or 400-cps operation. Pullout torque at 60 cps and 1800 rpm is 0.15 oz-in; 0.085 oz-in at 400 cps and 12,000 rpm. This is achieved by using a 1-mfd capacitor for 60 cps or a 0.1-mfd capacitor for 400 cps. Input voltage is 115 for both 60 or 400 cps.—*John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wis.*

For more information circle **282** on inquiry card.

MICROFILM PRINTER

New Unitizer permits microfilm users to unitize from original roll film to Actifilm sheet or to Filmsort aperture card or from Filmsort aperture card to Ozacard; reproduces and unitizes in one simple dry operation at minimal cost.—*Microline Products Group, Ozalid Div., General Aniline and Film Corp., Johnson City, N. Y.*

For more information circle **283** on inquiry card.

FOR...

Slip-On Insulation, Instrument Tubing, Bundle Sheathing, Medical Tubing, Pigtails...

USE **SPAGHETTI SLEEVING** MADE FROM **TEFLON***

PF Spaghetti sleeving has these important advantages:

1. Good dielectric strength (500 to 2000 volts/mil)
2. Excellent electrical properties at high temperatures (500°F) and a wide frequency range
3. Low coefficient of friction. It slips on easily in long lengths of wire up to 3 ft.
4. Eliminates the need for silver coated wire
5. Zero moisture absorption
6. Unaffected by any commercial chemical
7. Stress relieved for negligible shrinkage

25 sizes, 2 wall thicknesses, 10 colors in stock, 100% inspected and controlled dimensionally are available.

Write, wire or call for full details, competent engineering assistance and information on special sizes and walls. PF Teflon* flexible tubing, heavy-walled tubing and rod stock are also available.

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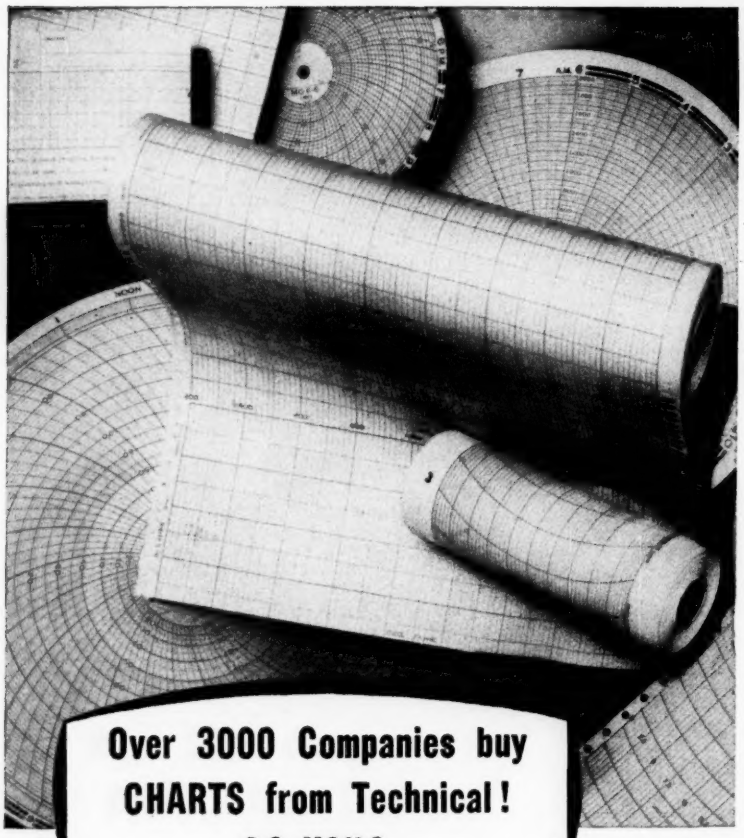
*Teflon—DuPont trade name for Tetrafluoroethylene resin

For more information circle **94** on inquiry card.



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Obvious economies result from "single source" purchasing of *all* recording charts. Why write a dozen purchase orders to different suppliers when *one* to Technical does the job? Fewer headaches, too, in "following through."

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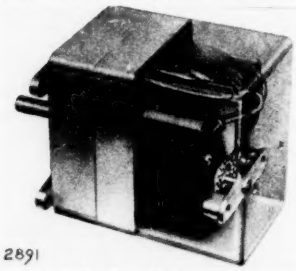
For more information circle **95** on inquiry card.

QUICK-STOP GEARMOTOR

New VW-1 shaded-pole gearmotor, for applications requiring slow or medium speed drive, is available with



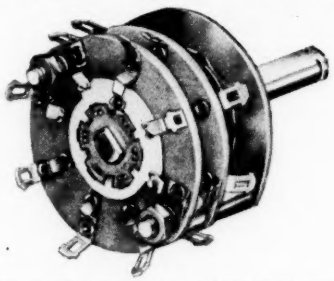
2891

a special clutch which disengages rotor from output shaft, permitting it to stop instantly and making starting torque equivalent to running torque. Various stack thicknesses provide a range of power up to 1/35 hp continuous operation; higher hp's for intermittent duty. Where reversing is required, design permits mounting two motors in tandem. Speeds from 1 to 200 rpm and torques up to 50 lb in at 20 rpm or less.—*von Wiese Gear Co., St. Louis, Mo.*

For more information circle **284** on inquiry card.

MINIATURE ROTARY SWITCH

New Series A rotary switch will fit in a 1⅛" circle; can be supplied in 8-, 10-, and 12-position wafers (this

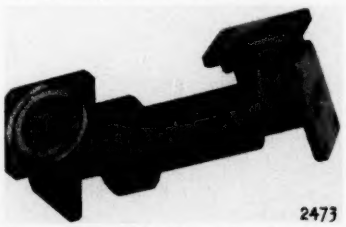


last providing up to 18 insulated contacts).—*Oak Mfg. Co., 1260 Clybourn Ave., Chicago 10, Ill.*

For more information circle **285** on inquiry card.

MICROWAVE CIRCULATOR

New compact Model RX 810 C broadband four-port circulator utilizes principle of Faraday rotation of



2473

plane of polarization of microwave energy; operates over 8.4-10.2 kMc band with a minimum of 13 db isolation and 0.35 db insertion loss. Can be pressurized to 30 psig.—*Rantec Corp., P. O. Box 108, Calabasas, Calif.*

For more information circle **286** on inquiry card.

VT VOM

New REL-500 ultra-high-impedance VTVM is said to give lab engineer an instrument capable of measurements previously impossible with general laboratory equipment. Basic measurements: voltages from 10 mv to 20 kv; currents from 1 ua to 2 ma; resistances (with resist multiplier) from 1 kilohm to 100 megohms. Built-in memory enables a measurement to be retained for hours—a distinct advantage in lab work; erasure is done manually, or automatically as a new input removes recorded reading. At least 16 applications of REL-500 are possible with maker's attachments.—*Rheem Mfg. Co., Electronics Div., 7777 Industry Ave., Rivera, Calif.*

For more information circle **287** on inquiry card.

TRANSISTOR POWER SUPPLY

New all-semi-conductor Model H3615 delivers 0-36 vdc at 0.15 amp; features rapid transient response;

recovery times <100 usec; combined load and line regulation <0.5% for 0-15 amp load and 105-125 v line; output ripple 3 mv over most of range.—*Deltron, Inc., P. O. Box 192, Glenside, Penna.*

For more information circle **288** on inquiry card.

LINEAR AMPLIFIER KIT

New LA-400-C linear amplifier kit, said to provide big savings on a build-it-yourself basis, operates on 75 through 10 meters; features TV interference suppression; measuring that reads RF voltage input, plate current, and RF amperes output; 400-watt peak envelope power input with only 20 watts drive; low-impedance input, pi-net output, with four modified 1625 tetrodes.—*P & H Electronics, Inc., 424 Columbia, Lafayette, Ind.*

For more information circle **289** on inquiry card.

TOROIDAL TRANSFORMERS

New standard line of toroidal transformers for dc to dc or ac transistorized converter applications includes dual-purpose transformers for switching power transistors and supplying various output voltages for compact single-transformer applications; available with power ratings to 120 watts, input voltages of 6, 12 and 24 vdc and output voltages to 600; choice of uncased, encapsulated, or hermetically sealed.—*Polyphase Instrument Co., Bridgeport, Pa.*

For more information circle **290** on inquiry card.

BRIDGE CALIBRATOR

New millivolt-per-volt standard for calibration and maintenance of strain gage systems provides a series of bridge outputs from 0.00 mv/v to 4.80 mv/v in eight increments. Nominal outputs are guaranteed accurate to 0.25 over 0-40°C temperature range. Exact calibration for each output is provided in a chart on instrument base to a guaranteed accuracy of 0.1% over same temperature range. Three standard models for bridge resistances of 120, 350, and 500 ohms.—*Bytrex Corp., 294 Centre St., Newton 58, Mass.*

For more information circle **425** on inquiry card.

TEMPERATURE INDICATOR

New Model 109, using thermistor primary elements, indicates temperature at ten different points to 0.1 C° accuracy. Because of their small size, thermistors assure "virtually instantaneous response." Ten points can be sensed within 60-90°C range by rotating selector switch. Model 109 can be easily adapted to other ranges and can be provided with more or fewer than ten points.—*Fenwal Electronics, Inc., Mellen St., Framingham, Mass.*

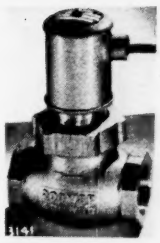
For more information circle **426** on inquiry card.

OSCILLOSCOPE

New Type 401-A general-purpose low-frequency oscilloscope offers front panel controls for calibration setting or switching from automatic to driven sweep; metric calibration and readout; exclusive externally or internally triggered "electronic shutter" for beam brightening; excellent sync lockout; and continuous use of *X*-and *Y*-amplifier controls without disturbing calibration.—*Allen B. Du Mont Labs., Inc., 750 Bloomfield Ave., Clifton, N. J.*

For more information circle **427** on inquiry card.

SOLENOID VALVES



New Type Q (n-c) and Type QR (n-o) fully-automatic 2-way packless bronze-bodied piston-pilot-operated valves are for use with heavier liquids, air and gases to 400 psi (steam to 200 psi) and temperatures to 450°F. Sizes $\frac{3}{8}$" to 3".—*J. D. Gould Co., 4707 Massachusetts Ave., Indianapolis 18, Ind.*

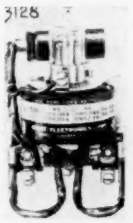
For more information circle **428** on inquiry card.

SUBMINIATURE VDR

New Trimpot Model 224 high-temperature humidity-proof voltage-dividing resistor, designed for application in missiles and high-speed aircraft, is so compact that 16 units will fit in one square inch of panel space. Body eyelets are on 1" centers for standard mounting. Self-locking 25-turn adjustment is virtually immune to shock and vibration. Nine standard resistances from 100 to 50,000 ohms.—*Bourns Labs., P. O. Box 2112, Riverside, Calif.*

For more information circle **429** on inquiry card.

TIME DELAY RELAYS



New full power sp-st, 2p-st and 3p-st time delay relays rated at 20, 35 and 60 amp or up to 5 hp @ 115 vac employ a cased high-reliability design thermal timer available in a wide choice of maker's MiniRelay, Standard or Heavy Duty power relays. New line is said to be "the first to offer such high load capacities in the non-mechanical timer field and feature hermetically-sealed positive mercury-to-mercury snap action."—*Ebert Electronics Corp., 212-26 Jamaica Ave., Queens Village 28, N. Y.*

For more information circle **430** on inquiry card.

MICROSCOPE

New Triple Nosepiece Microscope uses three color-corrected lenses to give "results vastly superior to standard single objective." Nosepiece rotates. Objective and eyepiece can be readily disassembled for cleaning.—*Edmund Scientific Co., Barrington, N. J.*

For more information circle **431** on inquiry card.

ACCURACY

in modern scientific

instruments often depends on controlling the direction of light without:

DISTORTION • DIFFRACTION

DIFFUSION

Consult the pioneers in evaporated metal coatings for:

- first surface mirrors with half-wave protection
- semi-transparent mirrors metallic and non-metallic
- beam splitters
- optical filters

Send for our free booklet. We have experience and skill to put at your service in solving your individual light problem.

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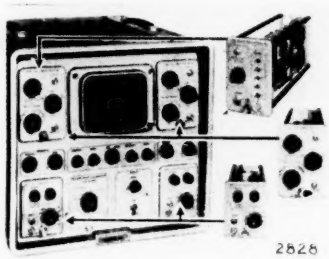
For more information circle **98** on inquiry card.

2-CHANNEL OSCILLOSCOPE

New Model K-270 offers wide selection of plug-in units. Five pre-amplifiers usable in any combination on



each channel cover sensitivity range from 50 mvdc/cm to 50 uvdc/cm; frequency response ranges dc-to-5 Mc to dc-to-50 kc. Two identical plug-in sweep generators permit viewing both channels on common or separate time bases. If separate sweeps are not required at the same time, unique plug-in Cali-Marker can be quickly substituted for one sweep generator. For the first time on any instrumentation 'scope, Model K-270 uses a new rectangular two-gun CRT, whose 4½" x 5½" face provides effective raster area of a conventional 7" round tube.—*Electronic Tube Corp.*, 1200 *E. Mermaid Lane, Philadelphia* 18, *Pa.*

For more information circle **291** on inquiry card.

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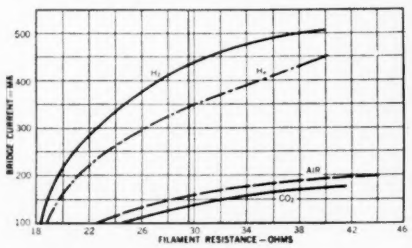
GOW-MAC

HIGH POSITIVE COEFFICIENT RESISTANCE FILAMENTS

For Repair, Experiment and Instruction in

- GAS ANALYSIS BY T/C
- PIRANI GAUGES • ANEMOMETERS

TYPE 9225 FILAMENTS (AVAILABLE IN MATCHED PAIRS) AMBIENT RANGE: —250° TO OVER 300°C.



METAL	FORM	RESISTANCE (OHMS) COLD	RESISTANCE (OHMS) OHMIC	CURRENT IN AIR AT ROOM TEMPERATURE MILLIAMPS D.C.	PRICE PER PAIR*
TUNGSTEN	HELIX	20	30	150	$10.00
TUNGSTEN (GOLD PLATED)	HELIX	18	27	150	20.00
KOVAR (ALLOY OF NICKEL, COBALT, IRON)	STRAIGHT	4	7	200	10.00

TUBE NUTS AVAILABLE. CAT. No. 9611 (Brass)... Price Per Pair .50
*Minimum order $50.00

Other Gow-Mac Products

- Portable and Panel Instruments
- Power Supplies (400 ma. D.C.)
- Thermal Conductivity Cells (Hot Wire and Thermistor)

GAS ANALYSIS BY THERMAL CONDUCTIVITY SINCE 1935

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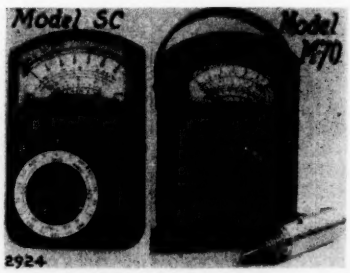
For more information circle **99** on inquiry card.

ELECTRICAL TESTERS

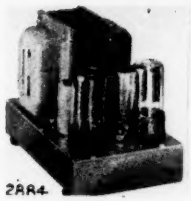
New Model SC and Model M-70 Multitesters are the first two instruments offered by exclusive U.S.A.



sales agent for Hansen Electric Laboratory & Works Ltd., Tokyo, Japan. Model SC has a sensitivity of 6,000 ohms per volt dc and 2,700 ohms per volt ac. Its 18 ranges include microamperes, direct-reading capacitance, inductance and decibels. Model M70, for research workers, etc., offers an unprecedented 30,000 ohms per volt dc, 15,000 ohms per volt ac on all normal scales. Its 60 useful ranges include audiofrequency 20 to 20,000 cps, audio, distortion, mutual conductance, direct-reading capacitance and inductance, and signal strength. Distributed by mail direct from factory to purchaser, who pays import duty on delivery.—*Dyna-vac Co., P. O. Box* 12146*G*, *Atlanta* 5, *Ga.*

For more information circle **292** on inquiry card.

DC POWER SUPPLIES

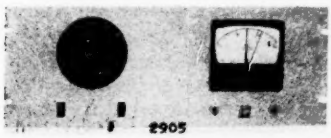


New Models RS-205 and RS-305, modular "packages" for chassis or subchassis use, can be ordered for rack-mounting application. Model RS-205 output 150-225 vdc @ 50 ma continuous duty; RS-305 output 225-325 vdc @ 50 ma. Input both models 105-125 v, 60 cps. Line regulation 0.1%; load regulation 0.1%; ripple and noise < 7 mv peak to peak max; recovery time < 25 usec.—*Trans Electronics, Inc.*, 7349 *Canoga Ave., Canoga Park, Calif.*

For more information circle **293** on inquiry card.

VARIABLE-VOLTAGE TESTER

New ac Varivolter speeds testing for effect of power-line voltage variations on output of power supplies,

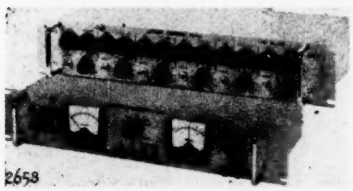


amplifiers, testers, computers, and control and servo systems. Output voltage sweep (rate 10 v/sec) 0 to 135 volts maximum, or any narrower range by setting independent upper- and lower-limit contacts. Models available for faster and slower operation, for 60- and 400-cps power lines; output current from 2 to 20 amp.—*Amplifier Corp. of America, Instrument Div.*, 398 *Broadway, New York* 13, *N. Y.*

For more information circle **294** on inquiry card.

STRAIN GAGE PANELS

New Models BC-264 (top) and BC-266 provide complete control of operating voltage and balance in four



or six bonded or unbonded strain-gage channels, respectively. From 1 to 4 active gages, of 60- to 1000-ohm resistance, can be employed in 2- or 4-arm circuits. Current is 0.1 amp max per channel. New panels permit a system starting with as few as 4 channels to be enlarged indefinitely without unnecessary duplication and at least expense.—*Owen Labs., Inc.*, 55 *Beacon Pl., Pasadena, Calif.*

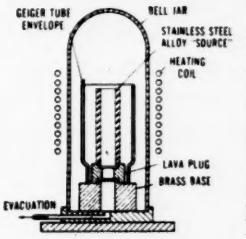
For more information circle **295** on inquiry card.

The Lepel Line of induction heating equipment represents the most advanced thought in the field of electronics as well as the most practical and efficient source of heat yet developed for industrial heating.

If you are interested in induction heating you are invited to send samples of the work with specifications. Our engineers will process and return the completed job with full data and recommendations without any cost or obligations.

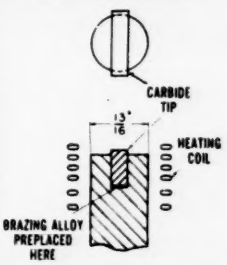
TYPICAL INDUCTION HEATING APPLICATIONS

METAL VAPOR COATING



The manufacture of Geiger Tubes requires a vapor coating of stainless steel inside of the glass envelope. The glass envelope is positioned inside of a bell jar which is connected to evacuation equipment. After evacuation, induction heating coil shown in position over bell jar heats the stainless steel source to high temperature causing vaporization. Condensation occurs on glass walls of the tube.

CARBIDE TIPS BRAZED TO GRANITE DRILLS



The drawing shows a carbide tip being brazed in the milled recess of a drill. High temperature brazing alloy is preplaced as indicated. Proper spacing of the turns of the heating coil extends the transition zone to avoid metallurgical notch and thereby fatigue failure. In a production set-up, the heating cycle can be preset so that every drill will be uniformly processed.

SELECTIVE HARDENING OF RAIL GROOVE

V-grooves in steel rails are selectively hardened by the coil shown. Heating and quenching occur progressively as the rail moves through the coil and a quench ring.

Electronic Tube Generators from 1 kw to 100 kw.
Spark Gap Converters from 2 kw to 30 kw.

WRITE FOR THE NEW LEPEL CATALOG — 36 illustrated pages packed with valuable information.

All Lepel equipment is certified to comply with the requirements of the Federal Communications Commission.

LEPEL HIGH FREQUENCY LABORATORIES, INC.
55th STREET and 37th AVENUE, WOODSIDE 77, NEW YORK CITY, N. Y.

For more information circle **100** on inquiry card.

HASTINGS

ABSOLUTE PRESSURE INDICATOR

Range: 0.1 - 20 mm Hg

THE VACUUM GAUGE IN THE MILLIMETER Hg RANGE

Practical - Inexpensive - Stable

Hastings Absolute Pressure Indicator is the first of its class—the finest in its field—and the *only* inexpensive electrical gauge now commercially available that covers the hard-to-measure range of 0.1 to 20 millimeters of mercury.

- Direct reading in millimeters of mercury
- Gives continuous reading or recording
- Responds rapidly to temperature changes
- Rugged construction—stable calibration
- Electric signal can be used to operate controllers of standard type
- Inexpensive, easily-cleaned, shock and vibration resistant gauge tubes
- Internal volume of gauge tube less than 1/20 cubic inch
- Ideal in applications where "fail-safe" operation is mandatory

Hastings Absolute Pressure Indicator, Model SP-1. Range: 0.1 to 20mm Hg, Expanded Scale from 0.5 to 5mm Hg

Models covering the 5 to 100 millimeters Hg range available on special order.

COMPLETE LINE OF INDUSTRIAL, COMMERCIAL, AND LABORATORY INSTRUMENTS.

AIR METERS • JET VANES • WIND VELOCITY RECORDERS • AIR DRIFT INDICATORS

VACUUM AND PRESSURE GAUGES

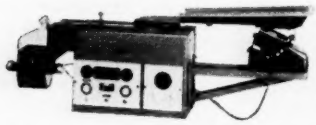
HASTINGS-RAYDIST, INCORPORATED

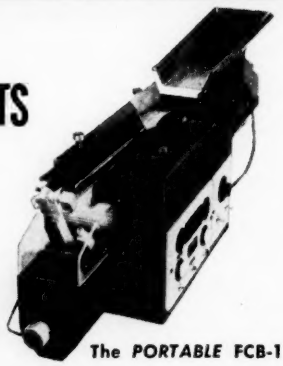
HAMPTON 49, VIRGINIA

For more information circle **101** on inquiry card.

POST DECITRON ELECTRONIC PRODUCTS

Now . . . low cost . . . accurate "batch" counting for small products.





The *PORTABLE* FCB-1

The Post FCB-1 is a sorting and counting device which incorporates a Syntron vibrator with a Decitron Preset Counter. Model illustrated utilizes a P2 counter, capable of 'batch' counting small objects in any quantity from 1 to 100.

Very small products can be neatly separated on the special conveyor belt . . . individually counted . . . dropped into a 'hold' tray and when the desired count is reached, the entire batch is fed into a waiting box, bag or other container. This latest Post development will feed 300 to 1000 pieces per minute and is **portable!** Size: only 53" long, 18" high, 12" wide. Cost as shown, $3500.

Post will be glad to furnish quotations for models capable of counting larger batches.

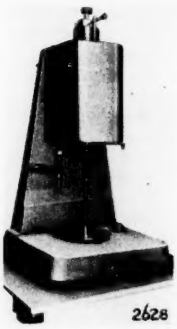
Decitron

POST ELECTRONICS

Division of Post Machinery Co. | 165 Elliott St., Beverly, Mass.

For more information circle **102** on inquiry card.

TORSIONAL DAMPING TESTER

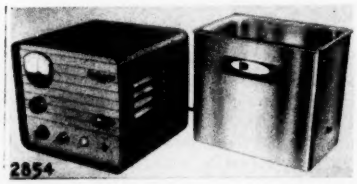


New Z-466, for investigating torsional elasticity and damping properties of plastics, rubber, etc., by dying-down of free oscillations, can provide temperatures from −50° C to 300° C in testing chamber when connected to refrigerator or heat source. A protective gas can be introduceed into testing chamber for specimens corroding in air. Frequencies from about 0.1 to 20 per second are determined by selection of inertia disc. A small mirror on inertia disc permits photographic recording of decrements.—*William J. Hacker & Co., Inc., 82 Beaver St., New York 5, N. Y.*

For more information circle **296** on inquiry card.

ULTRASONIC CLEANERS

New Series 600 is said to be "the first mass-produced line of high-capacity production-size ultrasonic

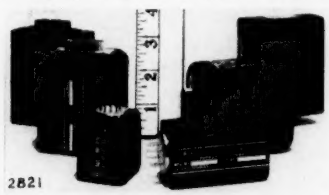


cleaners . . . available in this country." Photo shows SonBlaster Generator G-601 and SonBlaster NT-602 Transducerized Tank. Price of this combination is "about one fourth the price of comparable equipment available in the market." Series 600 line comprises 13 different systems made up of various combinations.—*Narda Ultrasonics Corp., 160 Herricks Rd., Mineola, L.I., N.Y.*

For more information circle **297** on inquiry card.

TELEMETERING OSCILLATORS

Six new voltage-controlled subcarrier telemetering oscillators feature size, weight and power require-

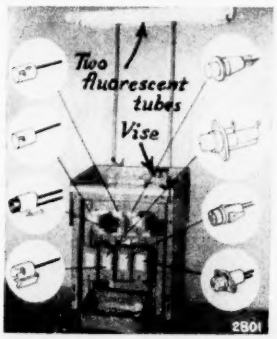


ments said to be the smallest on the market. Model 0.22, just over 1" cube, draws only 25 mw; 1 v gives 7.5% frequency change; input is 0.5 megohm and output up to several volts on RDB channels.—*Dorsett Laboratories, Inc., 401 E. Boyd St., Norman, Okla.*

For more information circle **298** on inquiry card.

INDICATING & DIAL LIGHT ASSORTMENT

New self-contained unit makes it possible to solve every indicating and dial light problem in 6-, 12-, 28-, 110-

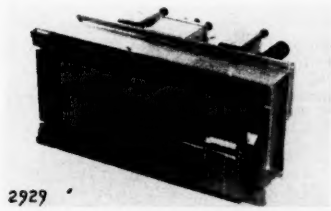


and 220-v applications; comprises work bench, complete tool assortment, materials, power, ample drawer space for storage.—*Alden Products Co.*, 117 *N. Main St., Brockton 64, Mass.*

For more information circle **299** on inquiry card.

DIODE FUNCTION GENERATOR

New Model 100 features a punched-card memory, is said to provide "accuracy and operational flexibility



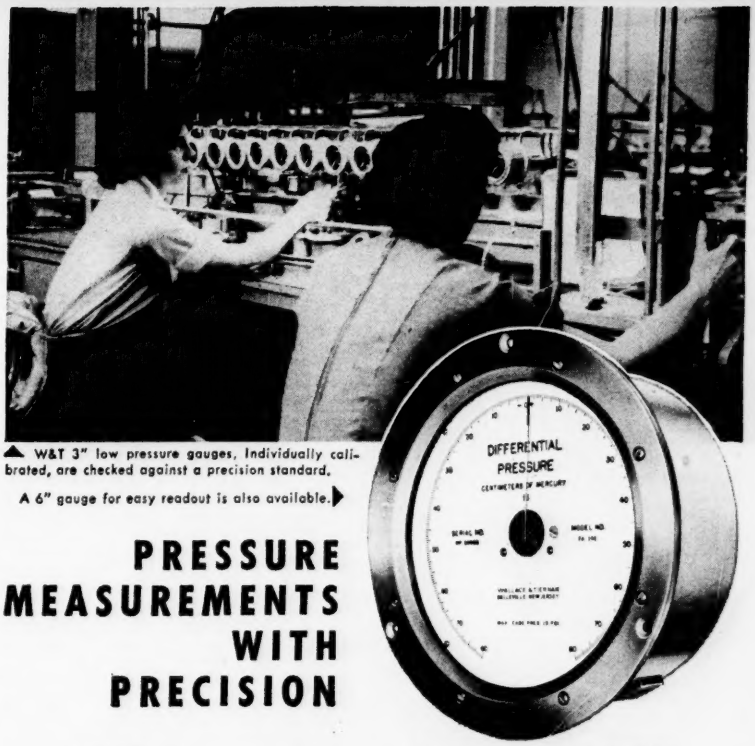
heretofore unavailable in non-linear equipment," can generate either non-linear functions of an independent input voltage (or of any parameter which can be converted to a voltage) or non-linear functions of time by using either an internal or an external time base. A complete library of non-linear functions can be created for future use and desired functions are available in seconds without need of adjustment or calibration.—*Electrol Inc. 9000 W. Pico Blvd., Los Angeles 35, Calif.*

For more information circle **300** on inquiry card.

LOGARITHMIC CONVERTER

New Model 21006 Precision Log Converter, accessory for maker's 256-channel analyzer, gives accurate logarithmic analog display on CR tube or strip-chart recorder; enables full range of counts from 1 to 65,535 to be read out in a single recording; provides output for either standard pen recorder or *X-Y* point plotter; switch-selected linear or log display; conversion time 80 usec per number.—*Radiation Counter Laboratories, Skokie, Ill.*

For more information circle **301** on inquiry card.



▲ W&T 3" low pressure gauges, individually calibrated, are checked against a precision standard.

A 6" gauge for easy readout is also available. ▶

PRESSURE MEASUREMENTS WITH PRECISION

W&T low pressure gauges bring 0.3% accuracy, rugged portability to your job

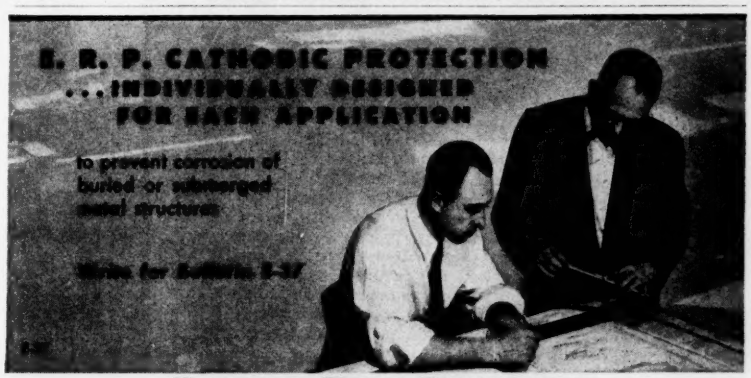
Calibration checked and double-checked . . . so you know the gauge is right when you record a reading. And W&T pressure gauges stay accurate in spite of rough handling. You can use them right on the job—still have laboratory accuracy.

These gauges are in stock now. For information write Dept. A-122.48

service: gauge pressure; differential pressure; vacuum determinations; or as compound pressure-vacuum gauges with zero center; **accuracy:** 1 part in 300; **sensitivity:** 1 part in 500; **minimum range:** 0 to 10 inches H_2O; **maximum range:** 0 to 400 inches H_2O; intermediate ranges of pressure or vacuum in any pressure equivalent are also available.

WALLACE & TIERNAN INCORPORATED
[illegible] MAIN STREET BELLEVILLE 9 NEW JERSEY

For more information circle **48** on inquiry card.


E. R. P. CATHODIC PROTECTION
. . . INDIVIDUALLY DESIGNED FOR EACH APPLICATION
to prevent corrosion of buried or submerged metal structures
Write for Bulletin E-57

ELECTRO RUST-PROOFING CORPORATION
30 MAIN STREET, BELLEVILLE 9, N. J.

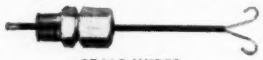
For more information circle **103** on inquiry card.

conax®

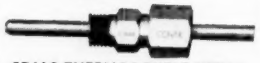
PACKING GLANDS

USING "SOFT" SEALANTS

UNIVERSAL
Any bore size available from 1/16" to ¾" diameter



SEALS WIRES



SEALS THERMOCOUPLE WELLS

SEALS TUBE ENDS

CONAX Packing Glands compress the "soft" sealant against any kind of tube, rod or wire with the following advantages:—

- Temperature range: −300°F to +1850°F.
- Pressure range: vacuum to 7500 psi.
- Non-destructive to sealed element
- Completely adjustable immersion
- Stainless steel construction
- Available "soft" sealants Neoprene, Teflon, Lava and Asbestos-Graphite
- Delivery from stock

WRITE FOR CONAX DATA BOOK SHOWING COMPLETE LINE OF THERMOCOUPLE ASSEMBLIES AND PRESSURE SEALING GLANDS.

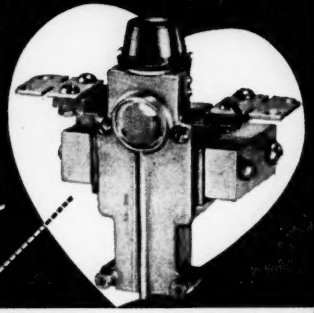
conax corporation
2316 Walden Ave., Buffalo 25, N. Y.

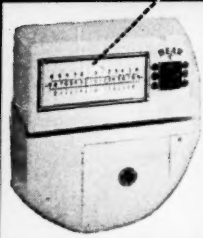
For more information circle **104** on inquiry card.

Make a GM PORTABLE D'ARSONVAL

GALVANOMETER

the Heart of Your Instrument



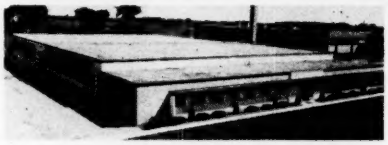


IN THE AUTOMOTIVE FIELD, the Bear Manufacturing Co. of Rock Island, Ill. uses Series 500 G-M Galvanometers in its new remote-reading Electric Wheel Alignment System (left). Whatever your own particular instrument field, you can achieve this same self-contained portability, ruggedness and high sensitivity with G-M Galvanometers. Complete catalog on request.

GM LABORATORIES • INC.
4316 NORTH KNOX AVE., CHICAGO 41

For more information circle **105** on inquiry card.

new plants and mergers



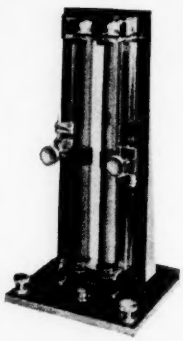
FISHER GOVERNOR CO. of Canada recently completed a 12,500-sq-ft addition to its factory.

BECKMAN INSTRUMENTS has acquired the assets of its wholly-owned subsidiary HELIPOT CORP. and will operate it as a division. At the same time LISTON-BECKER has been integrated with the Process Instrument Division. Manufacturing facilities of Helipot and Liston-Becker are being transferred to Fullerton.

THOMPSON-RAMO-WOOLDRIDGE CORP. is the new company resulting from the merger of THOMPSON PRODUCTS and its affiliate RAMO-WOOLDRIDGE CORP.

GENERAL PRECISION EQUIPMENT CORP's president E. A. Link announces expansion of a subsidiary, plus a name change. The former ASKANIA REGULATOR CO. is now GPE CONTROLS, INC. With the addition of certain products and technical services of three other GPE subsidiaries (Librascope, Link Aviation, and Kearfott) the GPE Controls line will include process control systems, process control computers and other data handling equipment, components and subsystems. Principal officers of GPE Controls are D. W. Smith, chairman; H. J. Velten, president; and G. L. Stancliff, Jr., executive vice president.

NIL TYPE M-12 PRECISION MANOMETER



- Operable to 150 PSI!
- Ranges 9-0-11 inches water or mercury
- Sensitivity 0.01% (0.001 in.)
- Precise pressure measurement

Write today for Bulletin 155

NATIONAL INSTRUMENT LABORATORIES, INC.
828 Evarts St., N.E., Washington, D.C.

For more information circle **106** on inquiry card.

ROBERTSHAW-FULTON opened a one half million dollar research and development center on the West Coast

to develop systems and automatic controls for air conditioning, space heating, refrigeration, food preservation, etc.

CLEVELAND PNEUMATIC INDUSTRIES has acquired **CLAUD S. GORDON CO.** and will operate it as a subsidiary.

J. W. FECKER, INC has become U. S. representative for missile range equipment manufactured by **CONTRAVES A. G.** of Switzerland.

ESCO PRODUCTS is now occupying its new 12,000-sq-ft plant at Oak Ridge, N. J.

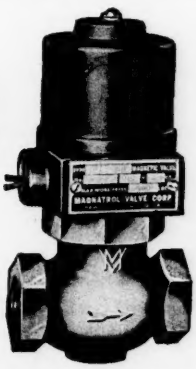
LERMA ENGINEERING CORP. has been formed with headquarters in Northampton, Mass. for the manufacture of remote viewing instruments, borescopes, inspection devices, optical systems, etc.

BRYANT CHUCKING GRINDER CO. has reorganized its Bryant Gage and Spindle Division and renamed it the **Bryant Computer Products Division.**

IT&T announced ground breaking ceremonies for a new 30,000-sq-ft plant to house the carrier and microwave facilities of **KELLOG SWITCHBOARD & SUPPLY CO.**

Eliminate

Costly Flow Failures



Magnatrol

SOLENOID VALVES

Quick Operating Non Sticking Tight Seating

These three design advantages are your assurance against costly flow failures. Attain dependable, accurate, automatic or remote control of liquids or gases with **Magnatrol Valves.** Installed quickly and easily in connection with . . . flow-meters, thermostats, float and time switches. **Every Magnatrol Valve** is delivered to you—factory **tested**—guaranteed free from defects in material and workmanship.

Available in normally closed or normally open models. Pressure ranges from zero up to 300 PSI. Voltages to 575.

Catalog containing complete specifications mailed upon request.

Magnatrol **VALVE Corp.**
HAWTHORNE 14
NEW JERSEY

For more information circle **107** on inquiry card.

FOR TESTING FABRICS THAT MUST HOLD GAS

The Cambridge Fabric Permeameter is an accurate, rugged and convenient instrument for production testing of the permeability of fabrics which are to be inflated with Hydrogen, Helium, Carbon Dioxide, etc.

The rate of permeation through the fabric is quickly determined by equipment utilizing the thermal conductivity method and is indicated in terms of liters per square meter per 24 hours of the retained gas.

Manufacturers of fabrics for lighter-than-air Craft, Life Rafts, Life Jackets, Gas Masks, etc., will find this an indispensable instrument. Send for particulars.

CAMBRIDGE INSTRUMENT CO., INC.
3554 Grand Terminal, New York, N. Y.

CAMBRIDGE FABRIC PERMEAMETER

For more information circle **108** on inquiry card.

PHILADELPHIA
THERMAL CONTROLS AND THERMOMETERS

Specify! **THE BEST!**

A half century of experience is back of every instrument we make. You get assured accuracy and long dependable performance when you specify "Philadelphia." Our specialized staff will be glad to discuss your problem in our field.

SEND FOR CATALOG 110

Since 1905

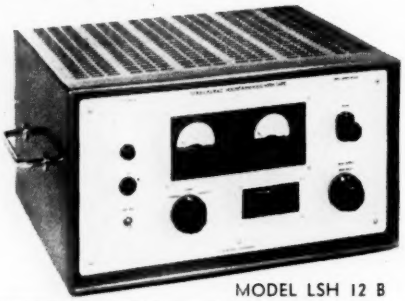
PHILADELPHIA THERMOMETER CO.
4401 N. Sixth St. • Philadelphia 40, Pa.

For more information circle **109** on inquiry card.

Regulated High Voltage

POWER SUPPLY

for photo multipliers, etc.



MODEL LSH 12 B

Output voltage	750-1600, 1500-2400, two ranges
Output current	0-25 mA
Ripple	less than 10 mV
Int. impedans	about 10 ohms
Regulation	0.4 Volts for a 10% line voltage change
Chassis	insulated, positive or negative may be grounded

OLTRONIX CO.

235 Underwood Drive, N. E. • Atlanta, Georgia

For more information circle **110** on inquiry card.

King MANOMETERS

Every Size — for Every Service

U-Type Manometers

- Single Cleanout
- Single Gland-Packed
- Double Cleanout
- Double Gland-Packed
- High Pressure

Low in price, Trouble-free, Easy to install and read

Well-Type Manometers

- Low Well
- Raised Well
- Barometric Reading

Stay clean longer, Easy to service

Multi-Tube Manometers

- Multi-Well
- Common-Well
- Special-Purpose

FREE LITERATURE gives sizes, construction and prices. Write today! And ask for informative 12-page Manual on Manometers.

KING ENGINEERING PRODUCTS include King-Gages — Manometers — Self-Closing Push Valves — Pressure Transmitters — Sight Feed Bubblers — Overflow Check Valves — Air-flow Snubbers — Sediment Traps — Moisture Indicators

KING ENGINEERING CORP.

Box 70 • Ann Arbor, Mich.

REPRESENTATIVES IN PRINCIPAL CITIES

For more information circle **111** on inquiry card.

people in the news

G. M. Muschamp

O. B. Wilson

W. H. Balentine

MINNEAPOLIS-HONEYWELL's Industrial Products Group has announced several personnel changes, among them appointments of *George M. Muschamp* to group vice president-engineering; *O. B. Wilson* to group vice president-marketing; *R. L. Mallory* to sales manager of the Industrial Products Group; and *J. A. Robinson* to sales manager of Brown Instruments division.

THOMAS A. EDISON INDUSTRIES has made *William H. Balentine*, who is manager of the Instrument Division, a vice president.

EPSCO has appointed *Alfred Bergman* of New York as special consultant for process control industry applications.

BECKMAN & WHITLEY announces appointment of *Myron Baldwin* as manager of its instrument division.

BLACK, SIVALLS & BRYSON has named *Charles R. Bootz* manager of the Controls Division in Tulsa.

U. S. RADIUM has named *James H. Atherton* chief engineer.

TYPE TJV FOR DC OPERATION VIDEO CONTACTS

Engineered specially for carrying video and other high frequency currents. Unusual flexibility of design permits a wide range of contact spring assemblies and combinations to be used. Fast operate, release and transfer time. Low interspring and spring-to-frame capacitance. Send for details.

COMAR

ELECTRIC COMPANY

3349 ADDISON ST., CHICAGO 18, ILL.

RELAYS • SOLENOIDS • COILS • SWITCHES • HERMETIC SEALING

For more information circle **112** on inquiry card.

E. J. Long

R. H. Smitter

C. Theodore

CONSOLIDATED ELECTRODYNAMICS has appointed *Everett J. Long* a director of the Transducer Division.

WAUGH ENGINEERING announces appointment of *Reuel H. Smitter* to general sales manager.

LING ELECTRONICS announces election of *Charles Theodore* as vice president in charge of sales.

SORENSEN & CO. has created a new post of manager of product and market planning which has been filled by *Nathan H. Magida.*

NORWOOD CONTROLS has appointed *C. Ronald Bach* applications engineer.

INTERNATIONAL RESISTANCE CO. announces appointment of *Edgar M. Corson, Jr.* to sales manager, new products marketing.

AMPEX announces promotion of *A. A. (Al) Sroka* to national sales manager for its Instrumentation Division. *Robert J. Ehret* was promoted to staff engineer, and *William E. Seaman* has been named senior staff engineer for the Advanced Video Development department of the Professional Products Division.

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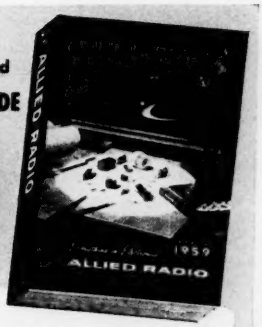

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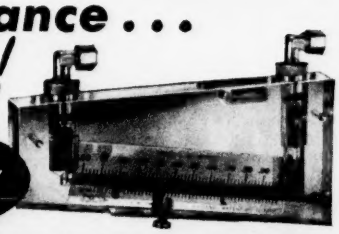

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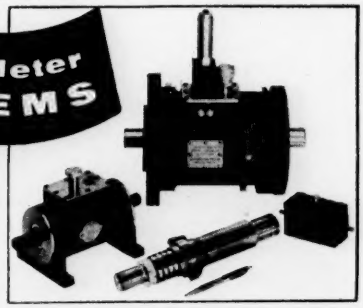
designed to meet your specific needs



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For more information circle **116** on inquiry card.

new literature

AUTOMATION

REMOTE CONTROL. 8-page catalog describes Crown Hydra-Trol remote controls, and typical applications of these manual hydraulic positioning devices.—Crown Controls Div., Trimount Instrument Co., 3119 W. Lake St., Chicago 12, Ill.

For more information circle **302** on inquiry card.

PROCESS CONTROL. 4-page bulletin describes Quantrol, an x-ray fluorescence analyzer for quantitative determinations in continuous-stream control.—Applied Research Laboratories, Inc., P. O. Box 1710, Glendale 5, Calif.

For more information circle **303** on inquiry card.

PROCESS AUTOMATION. 12-page Bulletin 101 describes the Abbey-Matic System, termed the "missing link" to complete process automation. —Abbey Process Automation, Inc., 37-10 48th Ave., Long Island City 1, N. Y.

For more information circle **304** on inquiry card.

BULK HANDLING AUTOMATION. Several 4-page bulletins deal with automatic batch control equipment and maker's Robac telephone-type dial control systems.—Hardy Electro-Matic Corp., Div. of Hardy Scales Co., 5701 Atlantic Blvd., Maywood, Calif.

For more information circle **305** on inquiry card.

SURGE CONTROL. 4-page Bulletin V-4007 describes Compressor Surge Control Systems used in the aeronautical test facility field.—CDC Control Services, Inc., 400 South Warminster Rd., Hatboro, Penna.

For more information circle **306** on inquiry card.

SPOT WELDER CONTROL. 4-page Bulletin 10-613 describes counting-tube type precision control for triphase electric resistance spot welders with power supply operating from 230 to 460 v, 60 cps, 3-phase.—The Taylor-Winfield Corp., Warren, Ohio

For more information circle **307** on inquiry card.

WASTES TREATMENT. 4-page Application Engineering Data Sheet D-58-1 describes continuous cyanide and chrome wastes treatment systems. Contains schematic flow diagrams.—Milton Roy Co., 1300 E. Mermaid Lane, Philadelphia 18, Pa.

For more information circle **308** on inquiry card.

MOTORS

PLANETARY MOTOR-DRIVES for variable transformers are subject of 2-page Bulletin SE-L2585.—Superior Electric Co., Bristol, Conn.

For more information circle **309** on inquiry card.

ROTARY EQUIPMENT. 120-page binder, Catalog 5721, contains 7 tabled sections; D-C; A-C, 60cps; A-C 400 cps; Motor Generator Sets; Gear Motors; Fans & Blowers; and Electronics.—Western Gear Corp., Electro Products Div., 132 W. Colorado St., Pasadena, Calif.

For more information circle **310** on inquiry card.

VALVES

CONTROL VALVES. 20-page Digest Catalog 58 with technical "Introduction to Air," covers air, solenoid, manuel, cam and auxiliary valves.—Ross Operating Valve Co., 120 E. Goldengate Ave., Detroit 3, Mich.

For more information circle **311** on inquiry card.

HIGH-PRESSURE VALVES. 8-page Bulletin 658 describes integrated line of bench-scale research equipment, specially designed for preliminary or exploratory studies in the laboratory. Built for pressure up to 5000 psi; includes valves, fittings, reactors, autoclaves and auxiliary equipment.—Autoclave Engineers, Inc., 2956 W. 22nd St., Erie, Pa.

For more information circle **312** on inquiry card.

HIGH-VACUUM VALVES. 2-page Data Sheet VG-4 and Catalog Sheet VG-5 detail unique features of high-vacuum gate valves used in nuclear and weapons development and space technology.—Vacuum Research Co., 420 Market St., San Francisco 11, Calif.

For more information circle **313** on inquiry card.

SOLENOID VALVES. 4-page Bulletin 500 C includes pictures and description of basic types of solenoid valves, covering a wide range of operating conditions.—J. D. Gould Co., 4707 Massachusetts Ave., Indianapolis 18, Ind.

For more information circle **314** on inquiry card.

RELIEF VALVES. 4-page Bulletin P-33 covers recently expanded line of 230 and 240 Series Safety Relief Valves for hot water space heating boilers.—McDonnell & Miller, Inc., 3500 N. Spaulding Ave., Chicago 18, Ill.

For more information circle **315** on inquiry card.

PRECISION VALVE SYSTEM. 4-page Bulletin 682 on precision measuring valve systems helps solve problems in dispensing measured quantities of fluid and semi-fluid materials.—Lincoln Engineering Co., 5703-31 Natural Bridge Ave., St. Louis 20, Mo.

For more information circle **316** on inquiry card.

SERVO VALVES. 4-page Bulletin 5801 provides basic design and performance data on high-fidelity servo valves.—Pesco Products Div., Borg-Warner Corp., 24700 N. Miles Rd., Bedford, Ohio

For more information circle **317** on inquiry card.

TEMPERATURE

WALL THERMOCOUPLES. 24-page Bulletin EDS-45 describes applications, advantages, and materials of construction of "Ceramo" Furnace Tube Wall Thermocouples.—Thermo Electric Co., Inc., Saddle Brook, N. J.

For more information circle **318** on inquiry card.

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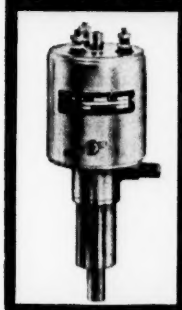
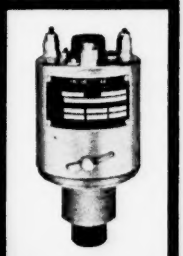


1 Switch UNDERSPEED OR OVERSPEED

2 Switches UNDERSPEED AND OVERSPEED



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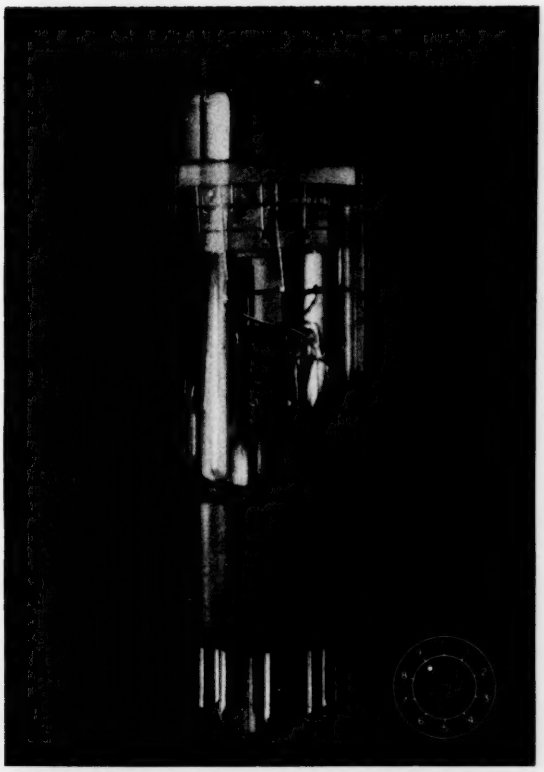

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S-60	1/5 sec.	60 min.	±.1 sec.
SM-60	1/100 min.	60 min.	±.002 min.
S-10	1/10 sec.	1000 sec.	±.02 sec.
S-6	1/1000 min.	10 min.	±.0002 min
S-1	1/100 sec.	60 sec.	±.01 sec.
MST	1/1000 sec.	.360 sec.	±.001 sec.
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For more information circle **120** on inquiry card.

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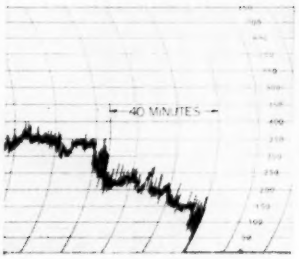

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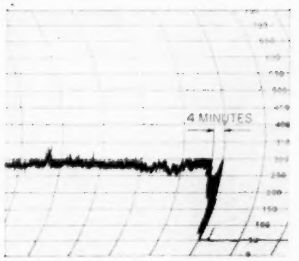

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NEW LITERATURE

THERMOWELLS. Data sheet 4582 on Weld-In Thermowells for the power and process industries shows typical installations of weld-in wells for thermocouples, resistance bulbs, bi-metallic thermometers, and mercury thermometers.—Trinity Equipment Corp., Cortland, N. Y.

For more information circle **319** on inquiry card.

CRYOGENIC REFRIGERATOR. 4-page Folder F-1059A describes LNR-25B Liquid Nitrogen Refrigerator.—Linde Co., Div. of Union Carbide Corp., 30 E. 42nd St., New York 17, N. Y.

For more information circle **320** on inquiry card.

TEMPERATURE CONTROLLERS. 2 page Bulletin 4-58-TM describes and specifies Model T-157M indicating, proportioning temperature controller series.—Electronic Processes Corp. of Calif., 2190 Folsom St., San Francisco 10, Calif.

For more information circle **321** on inquiry card.

PYROMETER SUPPLIES. 16-page catalog, Industrial Edition 8, illustrates and describes precision-matched pyrometers and thermocouples which can be used interchangeably with any make of pyrometer or thermocouple thermometer.—Raymond F. McHugh & Son, Box 6025, Phila. 14, Pa.

For more information circle **322** on inquiry card.

MAGNESIA INSULATION. 4-page Catalog Section 4 describes applications of Swaged MgO insulated wire: thermocouples and pressure probes used in jet engines, catalytic reactor thermocouple assembly, probe actuators, etc.—Aero Research Instrument Co., Inc., 315 N. Aberdeen St., Chicago 7, Ill.

For more information circle **323** on inquiry card.

FLOW, LEVEL, PUMPS

PLASTIC FLOW TUBE. Lightweight, low cost, corrosion-resistant insert plastic Dall Flow Tube, DFT-PI, is subject of 4-page Bulletin 115-RI.—Builders-Providence, Inc., 345 Harris Ave., Providence 9, R. I.

For more information circle **324** on inquiry card.

MAGNETIC FLOWMETER, utilizing principle of electromagnetic induction to produce an a-c signal, which is directly proportional to flow rate, is described in new 4-page Bulletin 10D1416.—Fischer & Porter Co., 787 Jacksonville Rd., Hatboro, Penna.

For more information circle **325** on inquiry card.

GRAVIMETRIC FEEDERS. 4-page Technical Publication TP-3-M describes Merchen Scale Feeder with variable speed drive for small quantities of chemicals for water and waste treatment, or process.—Wallace & Tiernan Inc., 25 Main St., Belleville 9, N. J.

For more information circle **326** on inquiry card.

LIQUID-LEVEL CONTROLS. 16-page Bulletin PF571 contains specifications, descriptive data, charts and dimensions of two types of liquid-level controls, electronic and electromagnetic.—Photoswitch Div., Electronics Corp. of America, One Memorial Dr., Cambridge, Mass.

For more information circle **327** on inquiry card.

POSITIVE-DISPLACEMENT PUMPS. 12-page Catalog 100, contains basic information on internal gear pumps, sliding-vane pumps and spur external gear pumps; also fluid motors and relief valves.—Tuthill Pump Co., 939 E. 95th St., Chicago 19, Ill.

For more information circle **328** on inquiry card.

MERCURY-VAPOR ILLUMINATOR for boiler water gages is described and illustrated in 2-page New Data Unit 336.—Jerguson Gage & Valve Co., 80 Adams St., Burlington, Mass.

For more information circle **329** on inquiry card.

TIME, SPEED

DC TACHOMETER GENERATORS. 12-page engineering report describes test procedures and test equipment used in determining the stability, linearity and other characteristics of d-c tachometer generators.—Servo-Tek Products Co., 1086 Goffle Rd., Hawthorne, N. J.

For more information circle **330** on inquiry card.

TIME DELAY TIMERS. 4-page Bulletin 300 describes seven series of synchronous-motor driven time delay timers with automatic reset.—Industrial Timer Corp., 1407 McCarter Highway, Newark 4, N. J.

For more information circle **331** on inquiry card.

TORQUE VS. RPM CHART. Chart, tabulates oz in torque vs RPM at stated hp.—John Oster Mfg. Co., Avionic Div., One Main St., Racine, Wis.

For more information circle **332** on inquiry card.

TIMERS. 2-page Bulletin 164 describes 5810-6010 series Range Timers.—The Lux Clock Mfg. Co., Inc., 95 Johnson St., Waterbury 20, Conn.

For more information circle **333** on inquiry card.

MINIATURE REPEAT-CYCLE DIAL. 4-page Bulletin N-80 describes miniature Atcotrol Duo-Set repeat cycle dial timer which controls two independently adjusted load circuits for on-off cycling.—Automatic Timing & Controls, Inc., Dept. 202, King of Prussia, Penna.

For more information circle **334** on inquiry card.

PRESSURE, FORCE, WEIGHT

WEIGHT INDICATORS. 4-page Brochure 658-B24, covers 18" Visual-Dial Indicator which can be remotely located and panel mounted; and Visual Numerical Indicator for desk use.—Streeter-Amet Co., Grayslake, Ill.

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PRESSURE/TEMPERATURE REGULATOR. 2-page bulletin contains information and diagrams on Model MR1000 Master Regulator for controlling pressure or temperature of boilers by adjusting fuel and air input, or gas or liquid pressure (or temperature) in process systems.—Optimum Control Corp., 2930 Woodhill Rd., Cleveland 4, Ohio

For more information circle **336** on inquiry card.

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NEW LITERATURE

RING DYNAMOMETERS. 4-page Bulletin 160 discusses construction, application and operation of ring dynamometers.—Morehouse Machine Co., 1742 Sixth Ave., York, Penna.
For more information circle **337** on inquiry card.

PROXIMITY PICKUP. 2-page Sheet 1164 describes PT3-1 Promixity Transducer for use with Dynagage to measure small mechanical displacements (such as strains troque, pressure, or vibration) over frequency range from 0 to 20,000 cps.—Photocon Research Products, 421 N. Altadena Dr., Pasadena, Calif.
For more information circle **338** on inquiry card.

TANK WEIGHING SYSTEM. 14-page Bulletin 581 covers hydraulic weighing system.—The A. H. Emery Co., New Canaan, Conn.
For more information circle **339** on inquiry card.

AIR

AIR SAMPLER. 2-page Bulletin N-31 details high-volume airborne particulate sampler HAS-4 which collects and measures radioactive or nonradioactive dusts, chemicals, and other pollutants from atomic plants, reactors, bomb tests, incinerators, isotope labs, manufacturing plants, mining operations, etc.—Nucleonic Corp. of America, 196 Degraw St., Brooklyn 31, N. Y.
For more information circle **340** on inquiry card.

BLOWERS AND FANS. 8-page catalog describes miniature axial and centrifugal blowers and fans for electronic cooling, ventilating, and exhausting.—Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.
For more information circle **341** on inquiry card.

AIRBORNE PARTICLE SAMPLER for use with vacuum systems and aspirators is described in 2-page Bulletin No. A-100.—Palo Laboratory Supplies, Inc., 81 Reade St., New York 7, N. Y.
For more information circle **342** on inquiry card.

ANALYTICAL, LABORATORY

MASS SPECTROMETERS, for process monitoring of gaseous or liquid streams are subjects of 2 bulletins: 16-page 1824C describes Types 21-610 and 21-620; 8-page 1834A is on Type 21-611.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.
For more information circle **343** on inquiry card.

PLASTIC LABWARE. 24-page Catalog 658 contains descriptions, illustrations and prices of bottles, dispensers, tubing, sheeting, etc.—Bel-Art Products, 4917 Murphy Place, West New York, N. J.
For more information circle **344** on inquiry card.

LABWARE. 878-page catalog, 12th Edition, contains ample information on laboratory equipment and apparatus. Includes new sections on chromatography and nuclear radiation; centrifuges, clinical-testing, electrical-testing, petroleum-testing equipment, distillation equipment, polyethylene ware, etc.—Request on business letterhead.—Emil Greiner Co., Dept. 1550, 20-26 N. Moore St., New York 13, N. Y.

For more information circle **345** on inquiry card.

DISSOLVED-OXYGEN ANALYZER. 4-page Bulletin 0-4014 describes Model 70 for continuous automatic analysis of dissolved oxygen in high-purity water.—Beckman/Process Instrument Div., Fullerton, Calif.

For more information circle **346** on inquiry card.

LAB EQUIPMENT. 200-page Catalog 158 illustrates and describes electric ovens, furnaces, baths, environmental cabinets, related temperature control equipment, and accessories. Contains 16-page comprehensive Technical Section.—Blue M. Electric Co., 138th & Chatham St., Blue Island, Ill.

For more information circle **347** on inquiry card.

OPTICAL

PHOTOGRAPHIC EQUIPMENT. 124-page Catalog 558-R contains photo supplies from cameras, enlargers, tripods, exposuremeters, to finishing equipment, lenses, etc.—Burke & James, Inc., 321 South Wabash Ave., Chicago 4, Ill.

For more information circle **348** on inquiry card.

HIGH-SPEED PRINT HEAD. Bulletin HH-389 describes Hi-Speed Head for continuous black and white printing at 200 ft/min.—Fish-Schurman Corp., 70 Portman Rd., New Rochelle, N. Y.

For more information circle **349** on inquiry card.

COORDINATE COMPARATOR. 2-page Bulletin 202-58 describes Coordinate Plate & Film Comparator.—Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.

For more information circle **350** on inquiry card.

DATA HANDLING

INFORMATION SYSTEMS. 8-page Bulletin E72-1 describes field measurements of process variables, as received and displayed in digital form by Metrotype Information Systems.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio

For more information circle **351** on inquiry card.

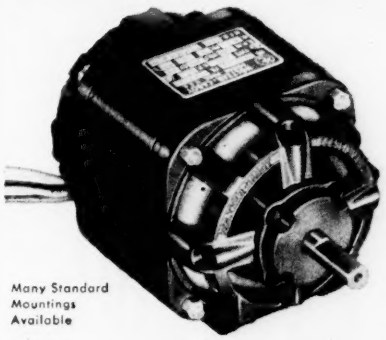
DATA PRESERVERS. 6-page Data Sheet 104 gives comparative test data, illustrations, description, and prices on tape data preservers (containers) to protect recordings from disturbing magnetic fields.—Magnetic Shield Div., Perfection Mica Co., 1322 No. Elston Ave., Chicago 22, Ill.

For more information circle **352** on inquiry card.

AN-DIG CONVERTERS.—8-page technical brochure starts with elementary text on digital systems and describes maker's direct-drive analog-to-digital code converters.—Kearfott Co. Inc., 1378 Main Ave., Clifton, N. J.

For more information circle **353** on inquiry card.

New Designs in Motors from HOLTZER-CABOT



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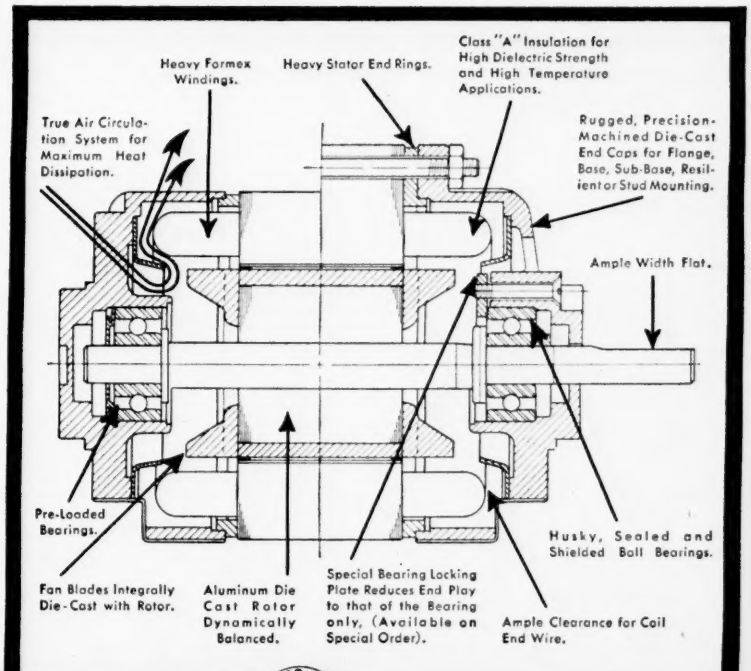
2⅞" Diameter

This motor is an ideal power source for recording instruments, timers, medical instruments, office equipment, blowers, tape recorders, communications equipment, etc. It is available in both 2-pole and 4-pole design, each in three stacking lengths. Type R-29 is a permanent split capacitor type available as an induction or synchronous motor. H.P. of various models ranges from 1/75 to 1/30. Construction features are indicated below.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Heavy Stator End Rings.
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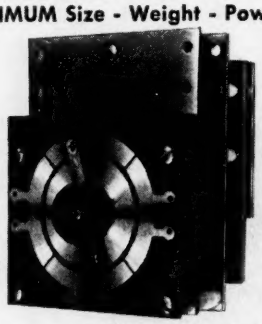
For more information circle **125** on inquiry card.

HIGH ALTITUDE
BALLOON
CONTROL INSTRUMENTS
require MAXIMUM Performance
MINIMUM Size - Weight - Power Drain



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For more information circle 128 on inquiry card.

NEW LITERATURE

INTEGRATORS. 6-page Catalog M11-1 contains description, pictures and specs of (1) linear, and (2) square-root integrators for strip-chart recorders and other low-force devices.—Librascope, Inc., 808 Western Ave., Glendale, Calif.

For more information circle **354** on inquiry card.

DIGITAL MODULES. 4-page Supplement A to Catalog M-2 describes Shift Flip-Flop, Model SF-101, and Plugboards Model PB-101.—Computer Control Co., Inc., 92 Broad St., Wellesley 57, Mass.

For more information circle **355** on inquiry card.

DIGITAL BUILDING BLOCKS. 4-page General Product Summary 658 contains illustrations and descriptions of transistorized circuits, vacuum-tube circuits, and other plug-in building blocks for digital systems engineering.—Engineered Electronics Co., 506 E. First St., Santa Ana, Calif.

For more information circle **356** on inquiry card.

LANGUAGE TRANSLATOR. 4-page brochure describes Model ZA-100 Computer Language Translator.—Electronic Engineering Co. of Calif., 1601 E. Chestnut St., Santa Ana, Calif.

For more information circle **357** on inquiry card.

RECORDERS

X-Y RECORDERS. 42-page Catalog-D contains bulletins on 9 types x-y recorders, card translators, keyboards, printers, logarithmic converters, voltmeters, etc.—F. L. Moseley Co., 409 N. Fair Oaks Ave., Pasadena, Calif.

For more information circle **358** on inquiry card.

OSCILLOGRAPH. 4-page bulletin describes portable 2-channel oscillograph package (Mark II) complete with built-in amplifiers.—Brush Instruments, 3405 Perkins Ave., Cleveland 14, Ohio

For more information circle **359** on inquiry card.

RECORDERS. 16-page Bulletin 6821 covers portable and switchboard models, type CF Inkless Recorder.—General Electric Co., Schenectady 5, N. Y.

For more information circle **360** on inquiry card.

RECORDER/REPRODUCER. 16-page Catalog 2002A covers special features of modular Magnetic Tape Recorder/Reproducer FR-100A.—Ampex Corp., Instrumentation Div., 934 Charter St., Redwood City, Calif.

For more information circle **361** on inquiry card.

MONITORS

ELECTRIC MONITOR. 2-page Bulletin 4.010 covers electric monitoring system which detects conditions of voltage, frequency, and phase in any power source, and is capable of operating switches, alarms, etc. in response to these variations.—Electric Regulator Corp., Pearl St., Norwalk, Conn.

For more information circle **362** on inquiry card.

TEMPERATURE SAFEGUARD. 8-page Bulletin 2002 describes Pyrotac, an excess-temperature protective device to sound an alarm and/or shut down upon reaching maximum safe temperature.—Illinois Testing Labs., Inc., 420 N. La Salle St., Chicago 10, Ill.

For more information circle **363** on inquiry card.

PROXIMITY CONTROL. 4-page bulletin describes high- and low-level, fail safe Proximity Control which can be used with non-conductive liquids, semi-solids, and free flowing granular materials.—Electronics Div., Trimount Instrument Co., 3119 West Lake St., Chicago 12, Ill.

For more information circle **364** on inquiry card.

ITV

ITV SYSTEM. 4-page catalog sheet covers ITV system, Model PD-250, comprising Viewfinder Camera, portable Camera Control Unit, studio-type Control Console, and accessories.—General Precision Laboratory Inc., 63 Bedford Rd., Pleasantville, N. Y.

For more information circle **365** on inquiry card.

ITV CAMERA ENCLOSURES. 2-page catalog sheet illustrates weatherproof and dustproof enclosures for ITV cameras.—Dage Television Div., Thompson Products, Inc., West Tenth St., Michigan City, Ind.

For more information circle **366** on inquiry card.

CC TELEVISION. 12-page Bulletin 2239 describes and illustrates ITV equipment with case histories of successful operations.—Diamond Power Specialty Corp., Electronics Div., Box 415, Lancaster, Ohio

For more information circle **367** on inquiry card.

TESTING,

PHYSICAL TESTING. 4-page bulletin describes operating theory, operation, and components of High-Rate Tester, Model 625B.—Allegany Instrument Co., Inc., 1091 Wills Mt., Cumberland, Md.

For more information circle **368** on inquiry card.

ENVIRONMENTAL TEST INSTRUMENTATION. 4-page Bulletin W 1831 covers indicating, recording, programming, and controlling instruments for environmental tests; also for temperature, humidity, altitude, pressure, flow, and other variables.—The Bristol Co., Waterbury 20, Conn.

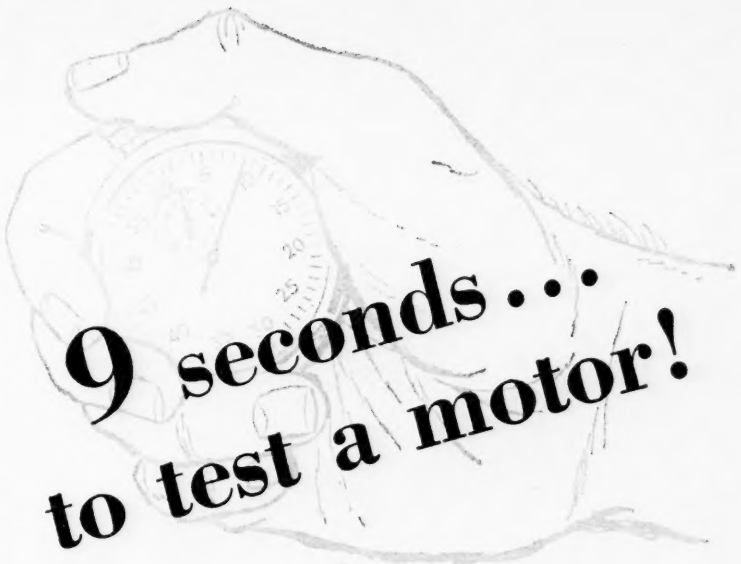
For more information circle **369** on inquiry card.

TRANSFER FUNCTION ANALYZER. 6-page bulletin describes British-made analyzer for networks, servomechanisms, automatic process control equipment, etc.—Solartron, Inc., Eastern Div., 40 Haddon Ave., Camden 3, N. J.

For more information circle **370** on inquiry card.

ENVIRONMENTS TESTS. 6-page Bulletin 59 describes and illustrates environmental test equipment for altitude, humidity, fungus, salt spray, rain and sunshine, etc. Contains tables on relative humidity, altitude/pressure, and temperature conversion.—Standard Cabinet Co., 56 Washington Ave., Carlstadt, N. J.

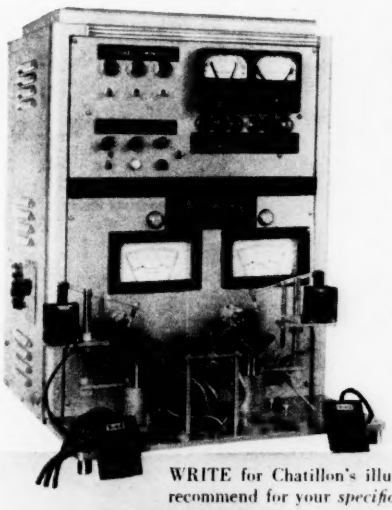
For more information circle **371** on inquiry card.



9 seconds... to test a motor!

That's all it takes now, with this Chatillon Running Torque Tester and Dynamometer. This specific model was designed for a manufacturer of fractional H.P. motors who wanted to be able to test them coming off the production line at the rate of one every nine seconds—using only one operator.

Ten different models of Running Torque Testers and Dynamometers of varying capacities are available—engineered and designed for precision accuracy to fit your individual fractional H.P. testing needs.



Features of Chatillon Running Torque Testers and Dynamometers for testing fractional H.P. motors:

RANGES 1" ounce to 320" lbs.

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Continuous ..... .04HP to .2HP
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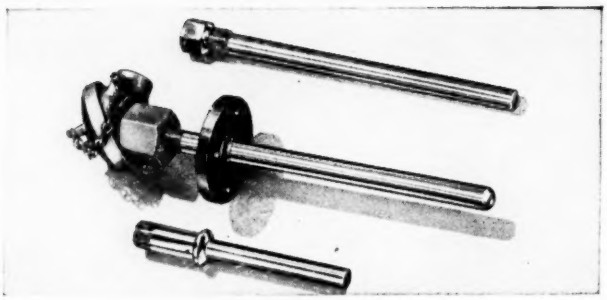

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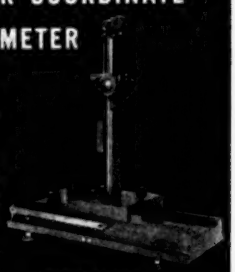

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For more information circle **131** on inquiry card.

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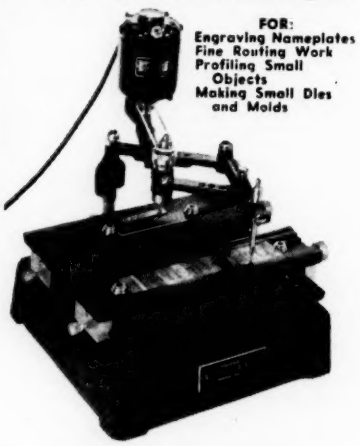

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For more information circle **132** on inquiry card.

NEW LITERATURE

GYRO TEST EQUIPMENT. 8-page bulletin contains pictures and descriptions of modular circuit components for gyro control, turntable control, metering, system self-check; also power supplies, and amplifiers.—Sterling Precision Corp., Instrument Div., 17 Matinecock Ave., Port Washington, L. I., N. Y.

For more information circle **372** on inquiry card.

ELECTRONIC TESTING EQUIPMENT. 36-page Catalog 58 covers a wide variety of attenuators, instruments, accessories, components, etc.—Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md.

For more information circle **373** on inquiry card.

MOTOR ANALYZER. 20-page Bulletin 621 Electronic Motor Analyzer for electric motor and solenoid production testing.—Automatic Development Co., 2530 North Naomi St., Burbank, Calif.

For more information circle **374** on inquiry card.

DIODE TESTER. Bulletin 1001 describes Dynamic Diode Tester, for rapid, accurate testing of semiconductor diodes.—Technitrol Engineering Co., 1952 E. Allegheny Ave., Phila. 34, Pa.

For more information circle **375** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

ELECTRICAL CONTROLS. 12-page Bulletin 106 shows how Versatrol controls operate.—Assembly Products Inc., 75 Wilson Mills Rd., Chesterland, Ohio

For more information circle **376** on inquiry card.

CIRCUIT PROTECTOR for use with semi-conductors, electronic data processing, instruments, small motors and power supplies is described in 4-page catalog.—Rowan Controller Co., 2313-2315 Homewood Ave., Baltimore 18, Md.

For more information circle **377** on inquiry card.

DIGITAL VOLT-OHMMETER. 2-page data sheet on Hycon Model 645AR, rack-mounted digital volt-ohmmeter, contains complete specifications and describes operating principles.—Hycon Electronics, Inc., 370 So. Fair Oaks, Pasadena, Calif.

For more information circle **378** on inquiry card.

ELECTROMETER. 4-page Bulletin 131 describes Model 31 Vibrating Reed Electrometer, used to measure radioactivity, ion currents in mass spectrometers, pH, electrical properties and similar applications.—Applied Physics Corp., 2724 South Peck Rd., Monrovia, Calif.

For more information circle **379** on inquiry card.

SIGNAL AMPLIFIER. 4-page bulletin describes new VS-102A power-post-amplifier for continuous-wave and sweep generators, providing a gain of 300 and a dynamic output range of 30 v peak-to-peak.—Millivac Instruments, P. O. Box 997, Schenectady, N. Y.

For more information circle **380** on inquiry card.

VARIABLE TRANSFORMERS. 4-page Data Sheet SE-L2583 describes two new small-frame series Powerstat variable transformers, which deliver a continuously-adjustable voltage from a-c power lines with higher ratings.—The Superior Electric Co., Dept. 117, Bristol, Conn.

For more information circle **381** on inquiry card.

INSTRUMENTATION SYSTEMS. 12-page 1958 catalog digest includes instruments, complete instrumentation systems, improved features, and brief informative descriptions.—Panoramic Radio Products, Inc., 514 South Fulton Ave., Mount Vernon, N. Y.

For more information circle **382** on inquiry card.

OSCILLOSCOPE. New 8-page quarterly technical bulletin entitled "METERS" (Measuring & Electronic Test Equipment Reports) describes a precision large-screen Bar-Graph Oscilloscope.—Industrial Products Div., International Telephone and Telegraph Corp., 250 Garibaldi Ave., Lodi, N. J.

For more information circle **383** on inquiry card.

ELECTRONIC INSTRUMENTS. 4-page bulletin describes and specifies electrometers, linear amplifiers, power supplies, pulse generators, and reference voltage sources.—Gyra Electronics Corp., 518 N. Spring Ave., La Grange Park, Ill.

For more information circle **384** on inquiry card.

SNAP-AROUND METER. 4-page Catalog No. A-583 delineates information on Amprobe line, comprising 7 volt-ammeter-ohmmeter models.—Pyramid Instrument Corp., Amprobe Div., 630 Merrick Rd., Lynbrook, N. Y.

For more information circle **385** on inquiry card.

SWITCHES, RELAYS

RELAYS, for ac and dc, (1) sensitive, (2) power and antenna type, (3) telephone type, and (4) hermetically sealed, are illustrated and described in 4-page Bulletin 58-3A.—Kurman Electric Co., Div. of Norbute Corp., 191 Newel St., Brooklyn 22, N. Y.

For more information circle **386** on inquiry card.

LIMIT SWITCHES. 4-page Bulletin 21 covers small, enclosed limit switches series "E6" and "V6".—Micro Switch, a division of Minneapolis-Honeywell Reg. Co., Freeport, Ill.

For more information circle **387** on inquiry card.

POWER SUPPLIES

DC POWER SUPPLIES. 2-page Bulletin SPS 4-58 contains descriptions, specs, and diagrams of three power supplies in Series 9293 for thermal conductivity cells used in gas chromatography or other instrumental gas analysis.—Gow-Mac Instrument Co., 100 Kings Rd., Madison, N. J.

For more information circle **388** on inquiry card.

POWER SUPPLIES. 2-page Bulletin PT 111.1 specifies, and describes with diagram, isolated-regulated transistorized a-c or d-c power supply.—Computer Engineering Associates, Inc., 350 N. Halstead, Pasadena, Calif.

For more information circle **389** on inquiry card.

New COX Flow Indicator

2% Accuracy

Type 7A

The Cox Flow Indicator provides a dramatic new dimension in direct reading instrumentation. Where accuracy and reliability are essential *at a low initial cost*, the Type 7 is the answer.

The Indicator is for use with Cox turbine flowmeters or other transducers producing a frequency signal directly proportional to flow rate. It is available for readout in either volumetric or gravimetric units—with specific gravity adjustment. A span adjustment enables the Indicator to be calibrated to any particular transducer. Panel and portable models are available.

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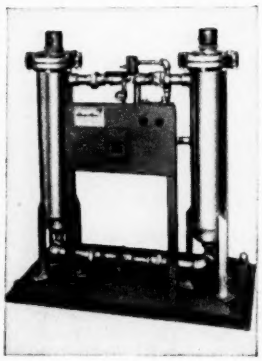

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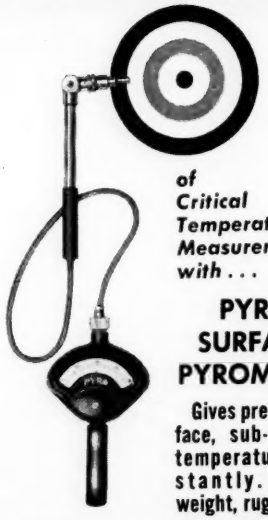

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For more information circle **136** on inquiry card.

NEW LITERATURE

POWER SUPPLIES, precision regulated, high-voltage, for scintillation detectors, ionization chambers, mass spectrometers, etc., made in five models, are described in 2-page leaflet.—Beva Lab., 22 Parker Ave., P. O. Box 478, Trenton 9, N. J.

For more information circle **390** on inquiry card.

ELECTRICAL, ELECTRONIC COMPONENTS

CAPACITORS. 2-page Bulletin 159 discusses characteristics of Series TS Tantalum Slug Capacitors; includes detailed physical and operating specifications with table of standard capacitance and voltage values.—Ohmite Mfg Co., 3694 Howard St., Skokie, Ill.

For more information circle **391** on inquiry card.

PRECISION POTENTIOMETERS. Data file includes four 2-page Bulletins PR-15, -19, -22, and -23 on linear single-turn rotary precision potentiometers of ⅞", 1 1/16", 1¼", and 1⅝" dia, respectively; and 16 std. spec sheets with dimensional drawings on single and multi-turn rotary, and rectilinear pots.—General Controls Co., 801 Allen Ave., Glendale 1, Calif.

For more information circle **392** on inquiry card.

PERMALLOY POWDER CORES with guaranteed inductance limits, varying no more than 8% above or below normal inductance per 1000-turn winding, are listed in 3-page Bulletin 1-P.—Magnetics Inc., Box 391, Butler, Penna.

For more information circle **393** on inquiry card.

PUSH BUTTONS. File sheet Bulletin 2901, Supplement A, gives features, construction and dimensions of single-element standard-duty push buttons.—Ward Leonard Electric Co., Mount Vernon, N. Y.

For more information circle **394** on inquiry card.

ELECTRONIC PRODUCTS. 80-page Catalog 158 lists hundreds of new aids in electronic chemicals, hardware, switches and service tools.—General Cement Mfg., Co. (div. of Textron Inc.), 400 S. Wyman St., Rockford, Ill.

For more information circle **395** on inquiry card.

ELECTRICAL COMPONENTS. 16-page illustrated folder, features wide assortment of relays, steppers, solenoids, rectifiers and related components.—Universal Relay Corp., 42 White St., New York 13, N. Y.

For more information circle **396** on inquiry card.

SLEEVING AND TUBING in teflon, plastic and fiberglass types are described in 20-page catalog T-58.—Birnbach Radio Co., Inc., 145 Hudson St., New York 13, N. Y.

For more information circle **397** on inquiry card.

TOROIDS, FILTERS, etc. 16-page Catalog 104 covers applications of toroids, filters and related networks.—Burnell & Co., 10 Pelham Parkway, Pelham, N. Y.

For more information circle **398** on inquiry card.

RETENTION CLAMPS. 16-page Catalog 5-KK, details 17 types of cooling and retaining clamps of silver and beryllium copper alloy for miniature and sub-miniature tubes and components.—Industrial Div., The Birtcher Corp., 4371 Valley Blvd., Los Angeles 32, Calif.

For more information circle **399** on inquiry card.

TOROIDAL CORES. 12-page Bulletin GTCC 5804 describes use of English-made Genalex toroidal cores; covers permeability, temperature co-efficient of inductance, d-c stability, core size, etc., and charts physical and electrical properties.—Wallace E. Connolly & Co., P. O. Box 295, Menlo Park, Calif.

For more information circle **400** on inquiry card.

PRECISION LINEAR TRANSDUCER.—2-page leaflet describes Type MA Rectilinear Transducer, for critical a-c measurement and servo applications in missile, aircraft and industrial systems.—Crescent Engineering and Research Co., 5440 N. Peck Rd., El Monte, Calif.

For more information circle **401** on inquiry card.

WIRE, CONNECTORS

SPIRAL WIRING TUBE. 2-page Bulletin T-2 describes and illustrates polyethylene Wiring Tube and shows application by means of "Cable-Former", a special wiring tool.—Panduit Corp., Dept. IAP, 14461 Waverly Ave., Midlothian, Ill.

For more information circle **402** on inquiry card.

FINE WIRE. Factors in drawing fine wire to 0.001" are discussed in new 8-page Brochure 358.—Nessor Alloy Products Co., 282 Halsey St., Newark 2, N. J.

For more information circle **403** on inquiry card.

WIRE MARKERS. 8-page bulletin describes pressure-sensitive wire markers.—North Shore Nameplate Inc., 214-27 Northern Blvd., Bayside 61, N. Y.

For more information circle **404** on inquiry card.

CONNECTORS. 24-page catalog covers pressurized and/or water-proof plugs, receptacles, caps, and cable clamps; high voltage receptacle and plug; etc.—H. H. Buggie, Inc., Box 817, Toledo 1, Ohio

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MECHANICAL COMPONENTS

MICRO BALL BEARINGS. 4-page bulletin contains dimensional drawings and tables of eight Microwafers, narrow-width small ballbearings.—New Hampshire Ball Bearings, Inc., Peterborough, N. H.

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WELDED BELLOWS. 2-page brochure describes metallic welded bellows which can be manufactured from 300 and 400 series stainless steels, 17-7 PH stainless steel, Inconel-X, Monels, Ni-Span-C, Hastelloys, titanium, zirconium, beryllium copper and other weldable materials.—Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co., 155 Hill St., Milford, Conn.

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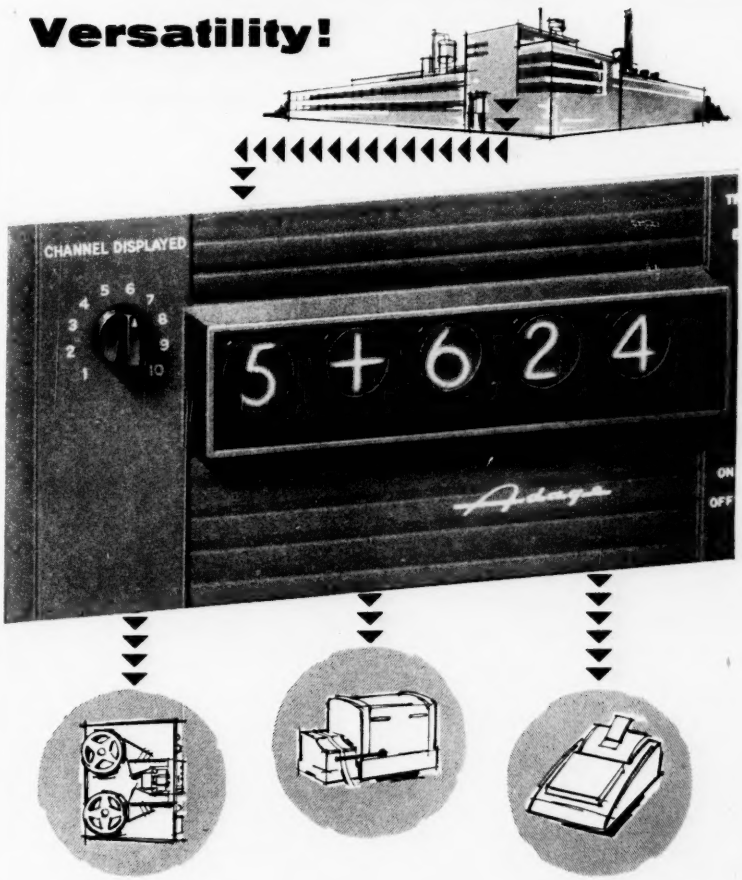

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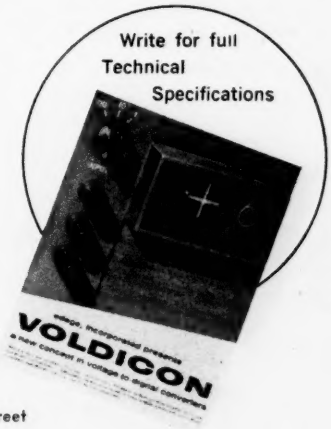

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INCORPORATED

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Cambridge 42, Mass.

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advertisers index

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Adage, Inc. 1593
Allen-Bradley Co. 1482
Allied Radio 1581
American Chain & Cable Co., Inc., Helicoid Gage Division 1569
Amperite Co., Inc. 1513
Automatic Switch Co. 1541
Avco Research and Advanced Development 1508

Bailey Meter Company 1477, 1507
Baird-Atomic, Inc. 1583
Barksdale Valves 1454
Bendix Aviation Corporation 1511
Berkeley Division of Beckman Instruments, Inc. 1545
B & F Instruments, Inc. 1581
Bird & Co., Inc., Richard H. 1562
Black, Sivalls & Bryson, Inc. 1517
Brailsford & Co., Inc. 1588
Bridgeport Thermostat Division 1492
Bristol Company 1464, 1510
Brooks Rotameter Company 1559
Brush Instruments Div., Clevite Corporation 1475
Bryant Chucking Grinder Co. 1456

Cambridge Instrument Co., Inc. 1579
Cannon Electric Company 1478
Chatillon & Sons, John 1589
Clare & Co., C. P. 1461
Clevite Corporation, Brush Instruments Division 1475
Comar Electric Company 1580
Conax Corporation 1578
Conoflow Corporation 1484
Consolidated Electrodynamics Corporation 1463
Cox Instruments Division, George L. Nankervis Company 1591
Cramer Controls Corporation 1505
Crescent Insulated Wire & Cable Co. 1504
Cubic Corporation 1486

DeZurik Corporation 1452
Dialight Corporation 1559
Du Mont Laboratories, Inc., Allen B. 1493
Dwyer Mfg. Co., F. W. 1581

Edison Industries, Inc., Thomas A., Instrument Division 1495
Electronic Associates, Incorporated 1542
Eppley Laboratory, Inc. 1474

Esterline-Angus Company, Inc. 1584
Evaporated Metal Films Corp. 1574

Fairchild Engine & Airplane Corporation, Stratos Industrial Products Branch 1585
Fenwal, Incorporated 1462
Fisher Governor Company 1466-1467
Foxboro Company 1502, 1536
Fulton Sylphon Division 1497

Gaertner Scientific Corporation 1590
General Automation 1586
General Controls Co. Back Cover
G-M Laboratories, Inc. 1578
Gow-Mac Instrument Co. 1574
GPS Instrument Co., Inc. 1547
Green Instrument Co., Inc. 1583

Hagan Chemicals & Controls, Inc. 1457
Hankison Corporation 1561
Hastings-Raydist, Incorporated 1576
Haydon Company, A. W. 1585
Hays Corporation 1459
Heiland Division, Minneapolis-Honeywell Regulator Co. 1472-1473
Helicoid Gage Division, American Chain & Cable Co., Inc. 1569
Heise Bourdon Tube Company, Inc. 1555
H. J. J. Company 1588
Hoke, Incorporated 1513

Illinois Testing Laboratories, Inc. 1559
International Register Company, Instrument Division 1485
International Resistance Company 1471
International Test Equipment Mfg. Co., Inc. 1586

Jones Optical Works, A. D. 1561

Kahn and Company, Inc. 1592
King Engineering Corp. 1580
Klipfel Valves, Inc. 1483

Leach Corporation 1494
Leeds & Northrup Co. 1514
Lepel High Frequency Laboratories, Inc. 1575
Leslie Co. 1530
Lewis Engineering Co. 1451
Librascope, Inc. Inside Back Cover
Liquidometer Corp. 1557
Lynn, Robert M. 1563

Mack Electric Devices, Inc. 1594
Magnatrol Valve Corp. 1579
Manning, Maxwell & Moore, Inc. Inside Front Cover
Marsh Instrument Co. 1565
Marshalltown Mfg. Company 1476
Mico Instrument Co. 1590
Mine Safety Appliances Company 1469
Minneapolis-Honeywell 1458, 1490-1491, 1498
Moeller Instrument Company 1561
Moore & Company, Samuel 1488

Nankervis Co., Geo. L., Cox Instrument Div. 1591
Nash Engineering Company 1500
National Instrument Laboratories, Inc. 1578
National Pneumatic Co., Inc. 1587
New Hermes Engraving Machine Corp. 1568
Ney Company, J. M. 1556
Norwood Controls 1479

Ohio Chemical & Surgical Equipment Co. 1501
Ohmite Manufacturing Company 1481
Oltronix Co. 1540, 1580

Pace Engineering Company 1565
Palmer Thermometers, Inc. 1592
Penberthy Manufacturing Company 1560
Pennsylvania Fluorocarbon Co., Inc. 1571
Philadelphia Thermometer Co. 1579
Post Electronics, Div. of Post Machinery Co. 1576
Pyrometer Instrument Co., Inc. 1592

Radio Frequency Laboratories, Inc. 1460, 1558
Reeves Soundcraft Corp. 1503
Rex Rheostat Co. 1594
RF Electronics, Inc., Division of Electro Switch Corporation 1565
Rockwell Company, W. S. 1564
Royal McBee Corporation 1551
Royson Engineering 1594

Sensitive Research Instrument Corporation 1452
Servonic Instruments, Inc. 1509
Shallcross Manufacturing Company 1499
Shore Instrument & Mfg. Co., Inc. 1588
Smith Co., S. Morgan 1550
Standard Electric Time Company 1584
Stevens-Arnold, Incorporated 1557
Sticht Co., Inc., Herman H. 1594
Stratos Industrial Products Branch, Fairchild Engine & Airplane Corporation 1585
Streeter-Amet Company 1540
Superior Tube Company 1487
Swartwout Company 1455
Synchro-Start Products, Inc. 1583

Technical Sales Corporation 1572
Telecomputing Corp. 1496
Thermo Electric Co., Inc. 1590
Thompson-Ramo-Wooldridge Products Company 1554
Tiffen Marketing Co. 1586

Uniflow Valve Corp. 1566
Unertl Optical Co., John 1592

Veeder-Root, Incorporated 1512

Wallace & Tiernan, Incorporated 1577
Wehsler Instruments Corp. 1489
Welch Scientific Company, W. M. 1553
Wiancko Engineering Company 1563
Wiley & Sons, Inc., John 1470

Zeiss, Inc., Carl. 1476

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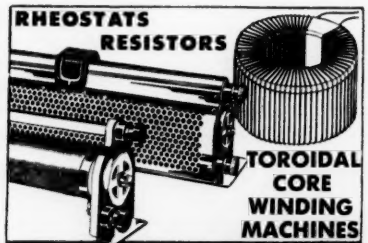

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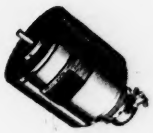
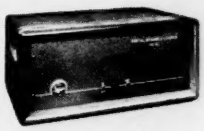


BCD Shaft Encoder... used where conversion to decimal form with ease is a requirement. All binary lines representing a decimal digit are parallel for ease of recording.

Sine-Cosine Shaft Encoder... presents sine and cosine functions simultaneously and independently. In addition, the limit one, quadrant and polarity data are supplied. Ideal for airborne automatic navigation systems, weapon control and tracking systems.



Digital Readout... performs logical brush selection operation in encoders using "V" scan. Also translates the unambiguous BCD encoder representation into parallel decimal form. Suitable for electric printers, lamp banks, etc.

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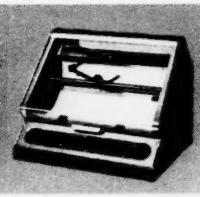
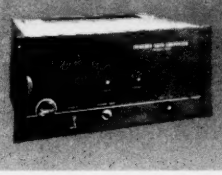
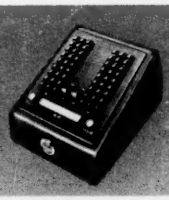


X-Y Plotter... for point or continuous plotting, with positive mechanical drive for recording graphic data. Several models available.

Punched Tape Converter... converts the digital information read from punched paper tape into input signals to the Librascope X-Y Plotter.



Punched Card Converter... converts data from IBM punched cards into analog input signals to the Librascope X-Y Plotter.



X-Y Decimal Keyboard... consists of 4 three-decimal bank for each axis with associated plus-minus keys.

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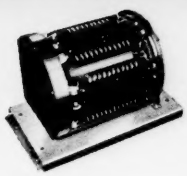
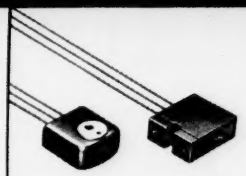
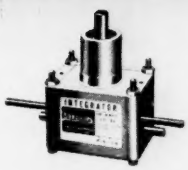


Magnetic Storage Drums... for medium storage applications; capacity 131, 072 non-volatile bits; several speeds; clock frequency 130 kc. Other models available.



Read-Record Heads... for high frequency, non-contact recording applications in magnetic memory systems; high readback signals. Transistor windings available.

Hollow and Solid Shaft Differentials... designed for high accuracy in additive and subtractive operations... has primary applications to angular velocity, sums and difference, and sequence operations.



Ball-Disc Integrator... for use in totalizing, rate determination, differential analyzers, closed loop servo-element, variable speed drive, temperature correction, etc.

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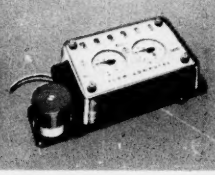
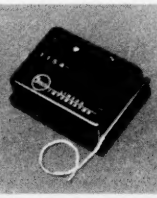
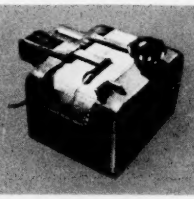


Flow Computer... extracts square root and continuously integrates both differential and static pressures for applications such as orifice measurement of gas.



Linear Integrator... for systems or instruments requiring integration, average computations, direct or remote reading... mounts in strip chart recorders.

Square Root Integrator... designed for the flowmetering industry to provide an economical, continuous, and compact integrator for automatic totalization of liquid flow.



Planimeters... for miniature strip chart recorders for simple integration with variable speed control; 2 models: square root and linear.

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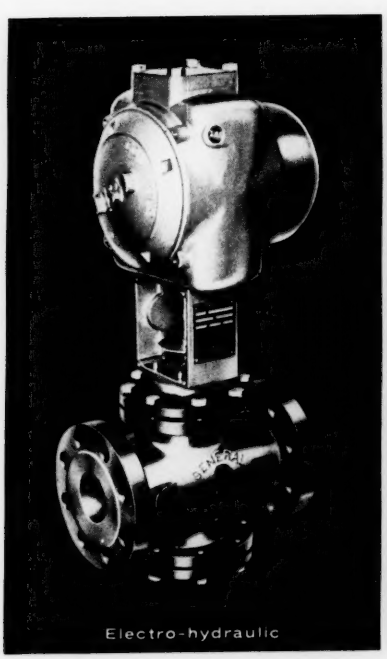

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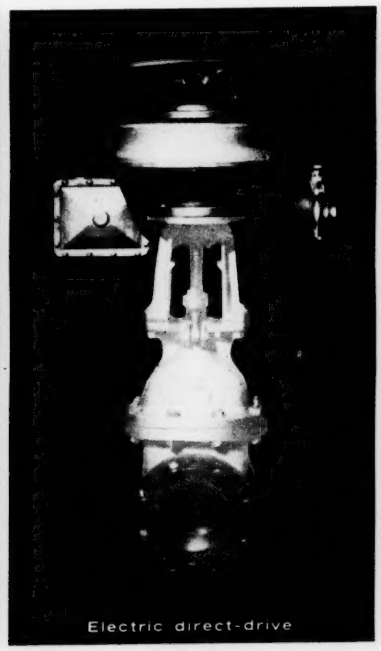
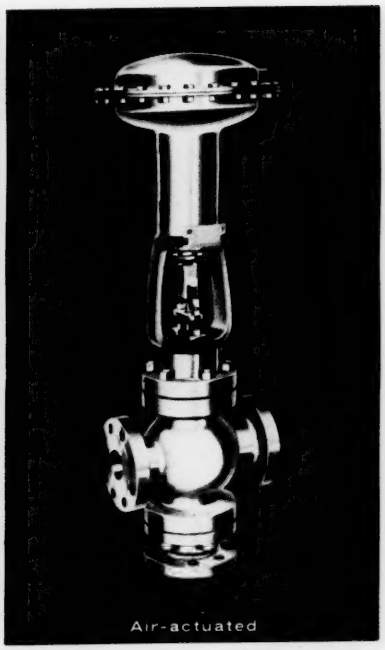


Electric direct-drive



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